May 18, 2007

Mr. Devender Narala
Regional Water Quality Control Board
1515 Clay Street, Suite 1400
Oakland, CA 94612

Subject: Corrective Action Implementation Work Plan
Building 1065 Area
Presidio of San Francisco, California

Dear Mr. Narala:

Enclosed is a copy of the *Corrective Action Implementation Work Plan of the Building 1065 Area (IWP), Presidio of San Francisco, California*, dated May 18, 2007 prepared by MACTEC Engineering and Consulting, Inc. (MACTEC) for the Trust. This document provides a detailed description of the field activities and other requirements the Trust will undertake to implement selected corrective actions identified in the *Final Building 1065 Corrective Action Plan (CAP), Presidio of San Francisco, California*, *dated January 2007.*

The Trust has recently procured a remediation contractor for the Remedial Unit A (RU-A) work and is preparing to begin the corrective action work by the end of June 2007. Prior to construction at RU-A, we have proposed to install a new groundwater well downgradient of Building 1063 to establish a baseline and monitor the success of our remediation. We are planning to install this well on May 30th and collect groundwater samples in early June. If acceptable to the Water Board, the Trust would like to schedule a site walk to determine the proposed well location on or before May 30th . For details regarding the proposed well, please see Section 4.4.6 and Plate 1-3 of the IWP to help prepare you for the upcoming site walk.

Please note, the Trust will provide the Water Board with an addendum to the IWP within approximately one month from the date of this letter. The IWP addendum will address corrective actions required for Building 1040 (Remedial Unit C). This work is being conducted by separate contractors on a separate construction schedule; however the results of the work will be incorporated into the Construction Completion Report for this project.

I will in be touch soon about setting up a site walk in late May as described above. We also look forward to working with you to complete this corrective actions required by the Building 1065 Area CAP. Please call me at (415) 561-4259 if you have any questions or comments.

Regards,

Craig Cooper
Remediation Program Manager

Enclosure

cc: Robert Boggs, DTSC
Brian Ullensvang, NPS
Doug Kern, RAB

Corrective Action
Implementation Work Plan
Building 1065 Area
Presidio of San Francisco, California

Prepared for

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May 18, 2007

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Corrective Action Implementation Work Plan
Building 1065 Area
Presidio of San Francisco, California

MACTEC Project No. 4089030006 00311

This document was prepared by MACTEC Engineering and Consulting, Inc. (MACTEC) at the direction of the Presidio Trust (Trust) for the sole use of the Trust, the National Park Service (NPS), and regulatory agencies, the only intended beneficiaries of this work. No other party should rely on the information contained herein without the prior written consent of the Trust. This report and the interpretations, conclusions, and recommendations contained within are based, in part, on information presented in other documents that are cited in the text and listed in the references. Therefore, this report is subject to the limitations and qualifications presented in the referenced documents.

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ACRONYMS AND ABBREVIATIONS

ACMs	asbestos containing materials
Army	United States Department of the Army
AST	aboveground storage tanks
BAAQMD	Bay Area Air Quality Management District
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylenes
BOD	biological oxygen demand
Cal OSHA	California Occupational Safety and Health Administration
CAP	Corrective Action Plan
Cleanup Level Document	Development of Presidio-wide Cleanup Levels for Soil, Sediment, Groundwater and Surface Water
COC	chemicals of concern
COD	chemical oxygen demand
Construction Documents	Construction Drawings and Technical Specifications
CQA	Construction Quality Assurance
County	County of San Francisco Department of Environmental Health
cy	cubic yards
°C	Celsius
DO	dissolved oxygen
DOT	Department of Transportation
DTSC	Department of Toxic Substances Control
EDD	electronic data deliverable
EKI	Erler and Kalinowski, Inc.
ERRG	Engineering/Remediation Resource Group, Inc.
ESLs	environmental screening levels
FDS	fuel distribution system
FPALDR	Fuel Product Action Line Level Development Report
GGNRA	Golden Gate National Recreation Area
GIS	Geographical Information System
GSA	General Services Agency
HASP	Health and Safety Plan
LUC	land use control
LUCMRR	Land Use Control Master Reference Report
MACTEC	MACTEC Engineering and Consulting, Inc.
MCLs	maximum contaminant limits
mg/kg	milligrams per kilogram
MS/MSD	Matrix Spike/Matrix Spike Duplicate
N Squared	NEPA and NHPA single review by the Trust
NEPA	National Environmental Policy Act
NHL	National Historic Landmark
NHPA	National Historic Preservation Act
NPS	National Park Service
ORC	Oxygen Release Compound
ORC Advanced ™	Oxygen Release Compound Advanced ™
ORP	Oxidation-reduction potential
PAH	polynuclear aromatic hydrocarbon
Phase I IA	Phase I Interim Action

PID	Photo-ionization detector
PLLW	Presidio Lower Low Water Datum of 1907
POTW	Publicly Owned Treatment Works
Presidio	Presidio of San Francisco, California
PTMP	Presidio Trust Management Plan
PVC	polyvinyl chloride
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
RAB	Presidio Restoration Advisory Board
RAO	Remedial Action Objectives
RAP	Remedial Action Plan
RU	remedial units
RUs-A	Remedial Unit A
RU-B	Remedial Unit B
RU-C	Remedial Unit C
Water Board	California Regional Water Quality Control Board
Water Board Order	Water Board Order No. R2-2003-0080
SCRs	Site Cleanup Requirements
sf	square feet
SF Coroner	San Francisco Coroner's Office
SOP	Standard Operating Procedure
the Site	Building 1065 Area, Presidio of San Francisco, California
SSHP	Site Safety and Health Plan
T&R	Treadwell & Rollo, Inc.
TPH	total petroleum hydrocarbon
TPHd	total petroleum hydrocarbon as diesel
TPHfo	total petroleum hydrocarbon as fuel oil
TPHg	total petroleum hydrocarbon as gasoline
the Trust	Presidio Trust
µg/L	micrograms per liter
USA	Underground Services Alert
USEPA	United States Environmental Protection Agency
UST	underground storage tank(s)
UXO	unexploded ordnance
VOC	volatile organic hydrocarbon(s)

1.0 INTRODUCTION

This Corrective Action Implementation Work Plan (Work Plan) has been prepared by MACTEC Engineering and Consulting, Inc. (MACTEC) on behalf of the Presidio Trust (Trust) to implement the corrective actions identified in the *Final Building 1065 Area Corrective Action Plan* (CAP; *MACTEC, 2007a*) to address soil and groundwater contamination at the Building 1065 Area, Presidio of San Francisco, California (the Site). The activities described in this Work Plan identify the fieldwork components of implementing the corrective actions to address soil and groundwater contamination that is related to or co-located with releases of petroleum hydrocarbons from past uses of the Site. The Construction Drawings and Technical Specifications (Construction Documents) provide additional detail regarding what is required of the Remediation Contractor for the excavation activities (*MACTEC, 2007b*).

1.1 Background

The Site is located in the northeastern portion of the Presidio of San Francisco, California (Presidio) (Plate 1-1). The Site was historically used for vehicle maintenance, and contained a service/gas station, garage, laundry with dry cleaning facility, crematory, paint shop, power house/steam plant, fuel oil storage, and fuel oil distribution lines, occupational therapy building, warehouses, isolation ward and prison, wagon shed, and an incinerator. As described below, the structures associated with former use of the Site for vehicle maintenance have been removed during previous investigations and corrective actions. The Site currently consists of historical buildings, paved parking areas, roadways, and some landscaping (Plate 1-2). Planned use of the Building 1065 Area includes commercial use in the southwestern portion of the Site, and commercial and recreational use for the remainder of the Site. A historical building at the Site (Building 1063) and the area to the south are planned to be used to house a recycled water treatment plant with a partially below-grade water storage tank. In addition, west of the Site is the planned location of the Tennessee Hollow riparian corridor.

Previous Investigations and Corrective Actions

Previous investigations conducted by the United States Department of the Army (Army) consisted of a Preliminary Assessment, Site Investigation, Remedial Investigation, and a draft Corrective Action Plan (*IT, 1996, 1997a, 1999a; D&M, 1997*). The Trust conducted a site characterization investigation to address data gaps identified from review of results of previous investigations, and an additional investigation at Building 1063, and has been conducting a quarterly groundwater-monitoring program at the Site. Previous corrective actions included removal of aboveground storage tanks (ASTs), underground storage tanks (USTs), fuel distribution system (FDS) lines, and a Phase I Interim Action (Phase I IA) excavation in the area of the proposed water treatment plant. Previous corrective actions included the following:

Army Corrective Actions (1993-1996)

- Removal of Building 1027 UST
- FDS Removal (Edie and Girard Roads; FDS line segments BR8-1, BR16-1, and BR10-3)
- Removal of Water Storage Tanks 1047.1, 1047.2, and 1047.3
- Removal of ASTs 1040.1 & 1040.2 and Associated Distribution Lines

- Removal of USTs 1065.1, 1065.2, 1065.3.

Trust Corrective Actions (2002-2004)

- Cleaning of Building 1047 Hydraulic Storage Tank and Elevator Pit
- Removal of Building 1062 Hot/Well Sump
- Removal of UST 1047.4
- Phase I IA
- Removal of UST 1065.4
- Birmingham Road FDS Line Removal.

Geologic and Hydrogeologic Conditions

Previous investigations show that the upper units comprise fill and shallow sand that are underlain by Bay Mud in the northern part of the Site and a silt unit (likely Colma formation) in the southern part of the Site. The Bay Mud and silt units are underlain by silty sands identified as the intermediate/shallow sand, upper and lower intermediate sand.

Two primary hydrogeologic units have been identified at the Site: a shallow groundwater zone and an intermediate groundwater zone. The shallow groundwater zone consists of saturated portions of the fill and, where present, the shallow sand. Groundwater in the shallow groundwater zone is unconfined and groundwater flow is to the northeast. The intermediate groundwater zone consists of the intermediate/shallow sand, upper intermediate sand, and lower intermediate sand. Groundwater in the intermediate zone is semi-confined and groundwater flow is generally to the north. There is an upward vertical gradient between the intermediate and shallow groundwater zones in the northern and central portions of the Site.

Review of groundwater monitoring data shows that the Bay Mud and the upward vertical groundwater gradient have been effective in reducing the downward migration of chemical contaminants. It also appears that reducing conditions exist in the shallow groundwater zone in the northern part of the Site where fill and the shallow sand are underlain by Bay Mud. Shallow groundwater in the southern part of the Site and in the intermediate groundwater zone appears to be slightly oxidizing. Redox conditions appear to have affected the relative solubility of metals in groundwater including arsenic, iron, and chromium. Arsenic and iron have been detected at higher concentrations in the shallow groundwater zone where reducing conditions exist, and chromium has been detected at higher concentrations in the shallow groundwater zone in the southern part of the Site and in the intermediate groundwater zone.

Nature and Extent of Contamination

The CAP evaluated data from previous investigations with respect to applicable cleanup levels to identify areas where contaminants were present at levels that could potentially pose risk to human health, the environment, or drinking water quality. Based on this review, there are three areas where contaminants are present above cleanup levels – (1) Building 1063, (2) parking lot west of Building 1063, and (3) beneath the west side of Building 1040.

Soil beneath, north, and south of Building 1063 contains benzo(a)pyrene, total petroleum hydrocarbons as diesel (TPHd), total petroleum hydrocarbons as fuel oil (TPHfo), total petroleum hydrocarbons as gasoline (TPHg), 2-hexanone, benzene, ethylbenzene, toluene, lead, cadmium, and arsenic above cleanup levels (Plate 1-3). Contamination in this area is likely the downgradient extent of a contaminant plume that extended north (downgradient) of the former Building 1065 USTs. The petroleum hydrocarbons detected at this location could also be from past releases from the former FDS lines that ran east-west along Birmingham Road and also ran north-south between Buildings 1040 and 1063.

In the parking lot, west of Building 1063, metals, TPHfo, TPHd, benzene, and benzo(a)pyrene were detected in soil at concentrations exceeding cleanup levels. Contamination did not appear to be at any specific horizon or location relative to identified potential source areas associated with past use of the Site. Petroleum hydrocarbons are likely from incidental spillage from vehicles parked or serviced in the area that may have been moved around and buried during demolition of buildings and re-grading of the Site. Metals and polynuclear aromatic hydrocarbons (PAHs) released to surface soil could have been similarly redistributed in fill areas during Site demolition and grading activities.

Beneath the west side of Building 1040, TPHfo and TPHd are present above cleanup levels in soil. Petroleum hydrocarbons detected in soil samples at this location may be from past leaks in the former FDS lines that entered the building or from the former fuel oil AST located immediately west of Building 1040.

A review of 2004 groundwater monitoring data and 2003 hydropunch data shows that TPHg, benzene, antimony, and arsenic have been detected above cleanup levels in the shallow groundwater zone in the vicinity of Building 1063. Except for antimony, there have not been any cleanup level exceedances in samples collected from the intermediate groundwater zone. TPHg and benzene, toluene, ethylbenzene, and xylenes (BTEX) detected in groundwater in the vicinity of Building 1063 are likely the downgradient end of a hydrocarbon plume originating from the former Building 1065 USTs. Groundwater monitoring data show that concentrations of TPHg and BTEX have declined over time and the decrease in concentrations are generally coincident with a decline in groundwater elevations observed at the Site that was likely the result of excavation dewatering at a nearby construction site *(T&R, 2003*). Groundwater at the Site was apparently being captured by the cone of depression created by the excavation dewatering. The decline in contaminant concentrations could be the result of water levels dropping below the smear zone, where petroleum hydrocarbons are adsorbed to soil particles, and/or movement of contaminated groundwater toward the cone of depression created by the excavation dewatering. This dewatering was conducted prior to implementation of the Phase I IA, in which contaminated soil was removed by excavation. Monitoring of a well (1065MW9A) downgradient of the Phase I IA excavation showed that TPHg and BTEX continued to remain non-detect or below cleanup levels following the Phase I IA excavation even after groundwater levels rose and groundwater flow resumed its normal pattern in response to cessation of the dewatering program. As a result, it appears that excavation of soil containing petroleum hydrocarbons was effective in reducing petroleum hydrocarbon concentrations in groundwater to below cleanup levels.

1.2 Remedial Action Objectives (RAOs)

The RAOs for the Building 1065 Area CAP Site include:

- Protection of human health and the environment;
- Cost-effective cleanup of the Site consistent with its potential land use;

- Recycling excavated materials such as concrete and asphalt to the extent practicable;
- Compliance with State and Federal environmental laws;
- Consistency of the selected corrective action alternatives at the Site with the overall transformation of the Presidio into a national park site; and
- Preference for permanent ("clean closure") remedies whenever practicable, cost-effective, and consistent with current or anticipated land use.

1.3 Remedial Units

Based on the occurrence of chemicals of concern (COCs) exceeding cleanup levels, the CAP identified three soil remedial units (RUs) and one groundwater RU (Plate 1-2). The CAP identified, evaluated, and selected a preferred corrective action alternative for implementation to address COCs present above cleanup levels within each of these RUs. The RUs are identified as the following:

Soil Remedial Unit A

Soil Remedial Unit A (RU-A) is located beneath, north, south of Building 1063 and comprises approximately 1,100 cubic yards (cy) of soil (Plate 1-2). At Soil RU-A, the COCs, benzo(a)pyrene, TPHd, TPHfo, TPHg, 2-hexanone, benzene, ethylbenzene, toluene, lead, cadmium, and arsenic, were detected above cleanup levels in vadose and saturated zone soil between 2.5 and 8.5 feet below ground surface (bgs). Contamination is not expected to extend below 8 to 8.5 feet bgs, the estimated top of the Bay Mud aquitard in this area.

Building 1063, constructed in 1941, is considered to be a historic structure of contributive value to the National Historic Landmark (NHL) and therefore, has been designated to be preserved. The building comprises a concrete slab floor, axial gable roof, roof support columns on 12-foot spacings, and walls composed of corrugated iron.

Soil Remedial Unit B

Soil Remedial Unit B (RU-B) is located in an area of debris fill in the northwestern portion of the Site. Because the areal extent of COCs in shallow soil at RU-B have not been fully characterized, a final corrective action for this RU could not be selected in the CAP. Soil RU-B will be investigated by the Trust as part of its upcoming remedial investigation related to Fill Site 6B.

Soil Remedial Unit C

Soil Remedial Unit C (RU-C) is located partially beneath the west wall of Building 1040, adjacent to a former fuel oil AST. At RU-C, the COCs, TPHfo and TPHd are present above cleanup levels in saturated soil at 7.7 feet bgs. The estimated volume of impacted soil is approximately 90 cy.

Building 1040 was constructed in 1920, and formerly operated as a power house/steam plant. The building is one story and is constructed of unreinforced brick masonry. The floors are concrete slab on grade. During a 2002 field investigation, the concrete floor in the eastern part of the building was shown to be over 4 feet thick and very difficult to penetrate. This steam plant is one of the few remaining structures of the original Letterman Hospital Complex. The building is a historic structure, and is of contributive value to the NHL and therefore has been designated to be preserved.

Groundwater Remedial Unit A

Groundwater Remedial Unit A comprises shallow groundwater (6 to 12 feet bgs) beneath and adjacent to the south wall of Building 1063 containing TPHg and benzene above cleanup levels. This unit is in the same general location as Soil RU-A, and is believed to be associated with contaminated soil found at that location. The plume does not appear to extend as far north as Soil RU-A because TPHg and benzene have not been detected above cleanup levels in samples collected from piezometer 1065PZ1.

Elevated dissolved arsenic concentrations in groundwater at the Site are likely the result of geochemical changes caused by locally reducing conditions from degradation of petroleum hydrocarbons in the shallow groundwater zone, and to a lesser extent from degradation of organic matter in the Bay Mud underlying the Site. Consequently, no formal arsenic groundwater RU has been established and groundwater monitoring for arsenic has been incorporated into the alternative for RUs-A. Additional information on arsenic concentrations and trends in groundwater related to the presence of petroleum hydrocarbons at the Building 1065 Area and adjacent CAP sites is presented in the *Technical Memorandum, Evaluation of Arsenic and Other Metals in Groundwater at Three Corrective Action Plan Sites, Presidio of San Francisco, California* (*MACTEC, 2006*).

1.4 Cleanup Levels

This section discusses the cleanup levels that were used to identify locations of the Building 1065 Area that require remedial action based on chemical concentrations measured in soil and groundwater during previous investigations at the Site (*MACTEC, 2003a*).

Cleanup levels for petroleum-related constituents in soil and groundwater at the Presidio were originally developed in the *Fuel Product Action Level Development Report* (FPALDR; *MW, 1995b*). In Order No. 96-070 (*Water Board, 1996*), the California Regional Water Quality Control Board (Water Board) adopted the FPALDR soil cleanup levels as Site Cleanup Requirements (SCRs) for petroleum hydrocarbons and related constituents in soil at the Presidio. These SCRs were maintained in the later the Water Board Order (*Water Board, 2003*). Since the issuance of the FPALDR and SCRs, cleanup levels for the Presidio have been proposed in the Cleanup Level Document (*EKI, 2002; Table 7-6 revised May 2006*). This document was developed by the Trust in consultation with the National Park Service (NPS), Water Board, United States Environmental Protection Agency (USEPA), Department of Toxic Substances Control (DTSC), and community members of the Presidio Restoration Advisory Board (RAB). For petroleum-related constituents, the SCRs for soil are proposed as Presidio-wide cleanup levels. For non-petroleum-related constituents, the cleanup levels were derived in the Cleanup Level Document and proposed as Presidio-wide cleanup levels.

The Cleanup Level Document identifies several steps to select appropriate site-specific cleanup levels (*EKI, 2002; Table 7-6 revised May 2006*). This includes identification of the following: impacted media, predominant soil lithologies, planned human land use, planned ecological land use, whether petroleum-related chemicals are present, and resources to be protected. The most stringent cleanup level is then selected as the appropriate cleanup level. Accordingly, the appropriate cleanup levels are media, location, chemical, and depth-specific.

For soil the most conservative cleanup levels were selected based on potential endpoints (e.g., protection of human health, ecological receptors [non special-status species], and water quality). For groundwater the cleanup levels were selected based on protection of human health (drinking water levels), protection of Freshwater Ecological Receptors, and for chemicals for which Presidio-wide cleanup levels have not

been established, maximum contamination limits (MCLs) or Water Board environmental screening levels (ESLs) were used as cleanup levels.

The CAP described the selection process for the cleanup levels in different areas of the Site; Tables 1-1 and 1-2 present the cleanup levels identified in the CAP for soil and groundwater, respectively, at the Building 1065 Area.

1.5 Chemicals of Concern

Concentrations of detected chemicals were compared to applicable cleanup levels to identify chemicals that were present at the Site at levels that could potentially pose risk to human health and the environment. Chemicals exceeding cleanup levels were identified as COCs because they were present at levels that could potentially pose risks to human health or the environment. Based on the occurrence and concentrations of chemicals in soil and groundwater at concentrations exceeding cleanup levels, the CAP identified the following COCs for cleanup in soil:

- Petroleum hydrocarbons - TPHfo, TPHg, and TPHd;
- Volatile organic compounds (VOCs) – benzene, ethylbenzene, 2-hexanone, and toluene;
- PAHs – benzo(a)pyrene; and
- Metals – arsenic, cadmium, lead, and zinc.

For groundwater, the CAP identified the following COCs:

- TPHg;
- Benzene; and
- Arsenic.

In 2006, the Trust conducted a study to further evaluate the presence of arsenic in groundwater and its relationship to petroleum hydrocarbons, soil types, and groundwater chemistry at the Building 1065 Area, and two neighboring CAP sites—the Building 207/231 Area and the Commissary/PX Area (*MACTEC, 2006*). Based on results of the study, arsenic is believed to be present in groundwater at elevated concentrations at these sites primarily due to degradation of petroleum hydrocarbons in saturated soils at or downgradient of a petroleum hydrocarbon release (from former USTs at the Building 1065 Area). It appears that arsenic is being mobilized from its adsorbed state on the iron coatings of soil particles due to more strongly reducing conditions imposed by the biodegradation of petroleum hydrocarbons present in saturated soils where petroleum releases occurred. To a lesser degree, arsenic may tend to mobilize into shallow groundwater due to locally reducing conditions caused by degradation of organic matter in the underlying Bay Mud. In addition, once the arsenic dissolves into groundwater, arsenic concentrations remain relatively stable over time. When the petroleum source and reducing conditions abate, arsenic concentrations may tend to slowly decrease due to dilution, dispersion, and transport.

1.6 Coordination of Corrective Action with Future Site Use

This corrective action was originally scheduled to take place in concurrence with construction of a water recycling plant which is to include the installation of water treatment tank inside the west end of Building

1063 and treated water holding tanks at the location of the former Building 1065. These water tanks were designed to be partially below grade and involve partial dismantling of Building 1063 prior to installation.

The Trust had planned to coordinate the remediation with the tank installation to allow for one dismantling operation. The water recycling plant project has faced several delays and the installation date has been postponed indefinitely, with a soonest possible construction date of 2008, resulting in an extended delay between the remediation and water recycling plant construction projects. As a result of this delay, the remediation will be conducted as a separate project. Shoring of the roof and removal of the support columns and all wood structures within the proposed excavation area will be conducted to allow adequate access for excavation activities. The support columns will either be replaced or the temporary roof supports and shoring will be left in place until the recycled water plant project begins. In addition, the excavation inside the building will be left "open" (i.e., not completely backfilled) to allow for the additional excavation needed for the installation of the water tank.

Building 1063 is a historical structure and corrective action implementation inside the building requires review and compliance with the Trust's regulations implementing both the requirements of the National Environmental Policy Act (NEPA) and the National Historic Preservation Act (NHPA). The Trust's NEPA and NHPA review processes are combined into a single review commonly referred to as "N Squared." N Squared approved removal of 16 roof support columns where the partially below-grade water tank is proposed as part of the future treatment plant. Subsequently, the extent of the excavation is laterally confined by the building walls and roof support columns.

1.7 Contracts to Implement Corrective Actions

The Trust will procure and manage a Construction Manager and contractors to implement the corrective action as shown on Chart 1-1 and summarized below:

- Remediation Contractor (Engineering/Remediation Resources Group, Inc. [ERRG])
- Construction Manager, Engineering Contractor, Construction Quality Assurance (CQA) Contractor, Building 1040 Outdoor Cap Inspection Contractor, and Land Use Control Contractor (MACTEC)
- Groundwater Monitoring and Well Abandonment/Installation Contractor (Treadwell & Rollo, Inc. [T&R])
- Building 1040 Indoor Cap Corrective Action (Erler and Kalinowski, Inc. [EKI]).

The details of each scope of work will be based on this Work Plan, the Construction Documents (*MACTEC, 2007b*), and a separate Building 1040 Indoor Cap Corrective Action Addendum to this Work Plan. The sequencing of pre-construction, construction, and post-construction activities and responsibilities associated with each contract, as well as parties involved in reviews and approvals of the corrective action tasks are summarized in Section 3.0. Reporting and documentation of these corrective action components are summarized in Section 7.0.

2.0 APPROVED CORRECTIVE ACTION

This section describes the approved corrective actions for each RU identified in the CAP and the activities needed to implement the corrective actions.

2.1 Soil and Groundwater Remedial Units A

The approved corrective action for co-located Soil and Groundwater RUs-A is excavation and offsite disposal of soil, application of in-situ oxygen releasing product as necessary, and groundwater monitoring until petroleum-related COCs are demonstrated to be below cleanup levels for four consecutive sampling rounds. All accessible petroleum-contaminated soil will be removed and disposed of offsite at an approved disposal facility. Excavation will continue until soil confirmation sampling results indicate that cleanup levels are met within excavation limits (Plate 1-3).

In order to treat residual petroleum contamination and address saturated soils and groundwater under the building foundation, an in-situ oxygen releasing product may be applied within the excavations prior to backfilling as summarized in Section 4.5.7 and described in Appendix D. After groundwater monitoring wells and piezometers have been abandoned and before excavation activities commence, a new monitoring well will be installed downgradient of Area 1 (Plate 1-3). A Land Use Control (LUC) will be implemented for groundwater in this area that will be lifted when groundwater monitoring shows concentrations of petroleum-related COCs and arsenic are below cleanup levels for four consecutive sampling rounds. Additional application of in-situ oxygen releasing product via in-situ injection may be considered if groundwater-monitoring data indicate the excavation of source materials and application of in-situ oxygen releasing product within the excavation has not reduced groundwater COCs to concentrations below cleanup levels. If results of groundwater monitoring indicate concentrations of COCs exceed cleanup levels approximately 18 months after the oxygen releasing product is applied, the effectiveness of the oxygen releasing product will be evaluated by the Engineering Contractor, and the stakeholders will be consulted in regards to the possible injection of additional oxygen releasing product. A separate technical memorandum will be prepared that summarizes the water quality data and may provide recommendations for further oxygen releasing product application, if needed.

This corrective action also includes continued groundwater monitoring at Groundwater RU-A shown in Table 2-1 for petroleum-related COCs TPHg and BTEX, arsenic, redox parameters, aluminum, iron, manganese, and field parameters to monitor the subsurface environment before and after application of oxygen releasing product to (a) assess the effectiveness of source removal and application of oxygen releasing product (if applied) in excavations at reducing residual petroleum contamination in groundwater; (b) verify COC concentrations in groundwater are not migrating offsite; and (c) assess whether concentrations of COCs and arsenic and redox parameters in wells and piezometers at the Site show trends over time. Groundwater samples including quality assurance/quality control (QA/QC) samples (duplicates, equipment blanks, and trip blanks) will be collected on a quarterly basis for one year and semi-annually thereafter. The Trust's Groundwater Monitoring Contractor will conduct the sampling, and results will be presented in Presidio-Wide Semi-Annual Groundwater Monitoring Reports as described in Section 7.0 of this Work Plan.

After petroleum-related COCs TPHg and BTEX, and arsenic are demonstrated to be below cleanup levels for four consecutive sampling rounds, monitoring will be discontinued (subject to Water Board approval), the LUC will be removed, and clean closure with regards to groundwater contamination will be documented in a Site closure report. Wells will be abandoned, as applicable, upon regulatory approval.

In accordance with Task 13 of Water Board Order R2-2003-0080, a Five-Year Status Report will be completed and submitted to the Water Board for approval. It is anticipated that the first Five-Year Status Report will be submitted in 2012.

2.2 Soil Remedial Unit B

Because the nature and extent of COCs in shallow soil at RU-B have not been fully characterized, a corrective action was not selected in the CAP. Further investigation and evaluation, and selection of remedial alternatives, will be addressed in the upcoming remedial investigation and Remedial Action Plan (RAP) for Fill Site 6B.

2.3 Soil Remedial Unit C

The approved corrective action for Soil RU-C is capping and institution of a LUC. The northwestern portion of the Building 1040 foundation will serve as a cap to isolate contaminated soil from exposure to potential receptors. The foundation and adjacent area will be inspected for improvements (e.g., sealing the flooring and any conduits to the subsurface, monitoring indoor air quality) to prevent occupant exposure to volatile COCs in vadose zone soils that may intrude into the building. This corrective action is consistent with the current and future reuse of this historic building that will be preserved and potentially occupied in the future. Because the contaminated soil will not be removed, this corrective action includes the development and implementation of a LUC to safeguard the cap, provide advance notice of Site conditions in the event of future ground disturbing activity, and restricts future land use to those compatible with safeguarding the integrity of the cap. The LUC Area for Soil RU-C is shown on Plate 1-3.

Implementation of the following three tasks associated with the corrective action for Soil RU-C will be performed and reported as separate activities from the corrective action for Soil and Groundwater RUs-A. All data, documentation, and results of corrective action activities for both RUs will be presented in the Construction Completion report:

<u>Indoor Air / Soil Vapor Sampling, and Cap Inspection</u>

A separate Building 1040 Indoor Cap Corrective Action Work Plan will be prepared as an Addendum to this Work Plan by the Trust's Building 1040 Indoor Cap Corrective Action Contractor (EKI) to describe the specific actions needed to inspect the indoor cap, identify the need for improvements, and conduct the assessment of potential vapor intrusion to indoor air and indoor air sampling in accordance with the DTSC Guidance (*DTSC, 2004*) inside Building 1040. Documentation procedures for the Building 1040 Indoor Cap Corrective Action are described in Section 7.0 of this Work Plan; the project team responsibilities associated with this corrective action are summarized in Table 3-1; and the scheduling associated with this corrective action is shown on Plates 8-1a and 8-1b. As described in Section 7.0, the results of the Building 1040 Indoor Cap Corrective Action, including all progress reports, implementation reporting communications, data, and records will be documented in the Construction Completion Report.

<u>Outdoor Cap Inspection</u>

The objectives of the Outdoor Cap Inspection are to inspect and document the existing surface outside the footprint of the building. This work will be performed by the Trust's Engineering Contractor (MACTEC). The existing outdoor cap over this LUC area (shown on Plate 1-3) consists of soil cover. The surface of the cap is currently unlandscaped bare soil on the west side of Building 1040 and concrete and asphalt pavement on the north side of Building 1040. The inspection and documentation will include

taking photographs and preparing a written description of the existing outdoor cap by the Engineering Contractor. Because the cleanup level exceedances are below 5 feet bgs, the overlying soil serves as a cap, and surface improvements (e.g., paving) are therefore not proposed. However, if during inspection, it is determined there is significant variability in the surface elevation that may cause ponding or directional surface water flow towards known locations of subsurface contamination that would increase the potential for contaminant migration, the Engineering Contractor will consult with the Trust, NPS, and stakeholders regarding the need for backfilling holes and/or paving the area surrounding the building and within the designated LUC. If physical improvements are determined to be necessary based on the inspection by the project team, the Remediation Contractor (ERRG) will perform the improvements, and the results will be documented in: (1) the weekly progress reports during construction; (2) the Construction Completion report; and (3) the Site-Specific Addenda to the *Land Use Control Master Reference Report for the Presidio* (LUCMRR) (*Trust, 2006*). Documentation procedures for the outdoor cap inspection are described in Section 7.0 of this Work Plan; the project team responsibilities associated with this corrective action are summarized in Table 3-1; and the scheduling associated with this corrective action is shown on Plates 8-1a and 8-1b. As described in Section 7.0, the results of outdoor cap inspection, including all progress reports, implementation reporting communications, data, and records will be documented in the Construction Completion Report.

Land Use Control

The Trust's Engineering Contractor (MACTEC) will prepare a site-specific addendum to the LUCMRR, which will describe the procedures the Trust will use to track, implement, and enforce the LUC as described in Section 5.0 of this Work Plan. Documentation procedures for the LUC are described in Section 7.0 of this Work Plan; the project team responsibilities associated with this corrective action are summarized in Table 3-1; and the scheduling associated with this corrective action is shown on Plates 8-1a and 8-1b. As described in Section 7.0, the Site-Specific Addendum to the LUCMRR, including all progress reports, implementation reporting communications, data, and records will be documented in the Construction Completion Report.

This corrective action does not include groundwater monitoring because no petroleum-related COCs have been identified in groundwater at RU-C above cleanup levels. The LUCs for Soil RU-C will be addressed further in the Corrective Action Completion Report. In accordance with Task 13 of Water Board Order R2-2003-0080, a Five-Year Status Report will be completed and submitted to the Water Board for approval. It is anticipated that the first Five-Year Status Report will be submitted in 2012 and will include the status of both RUs-A and RU-C.

2.4 Closure of USTs, ASTs, and FDS Lines

As part of the implementation of the CAP through corrective actions at Soil and Groundwater RUs-A and Soil RU-C, it is anticipated that residual contamination associated with ASTs 1040.1 and 1040.2, USTs 1065.1, 1065.2, 1065.3 and 1065.4, and the Birmingham Road FDS lines (un-named FDS line segment) will be addressed and that these units can be closed upon completion of the corrective actions. The request for closure will be presented in the Completion Report documenting implementation of the selected corrective actions.

3.0 PROJECT TEAM RESPONSIBILITIES

Key project team members include the Trust as owner, the Construction Manager, the Construction Quality Assurance (CQA) Contractor, and the contractors that will implement the corrective action identified on Chart 1-1, as well as the project team members including the Water Board, NPS, DTSC, and RAB. Table 3-1 describes the responsibilities of the project team prior to construction, during construction, and post-construction. The Construction Documents provide additional detail regarding what is required of the Remediation Contractor (ERRG) for the excavation activities (*MACTEC*, *2007b*). The Building 1040 Indoor Cap Corrective Action Work Plan Addendum will provide details regarding the corrective action implementation at RU-C. The project team points of contact are included in Table 3-2.

4.0 CORRECTIVE ACTION IMPLEMENTATION FOR SOIL AND GROUNDWATER - REMEDIAL UNITS A

Implementation of the approved corrective action for Soil and Groundwater RUs-A is described in this section. For ease of discussion, the three separate excavation areas of Soil RU A are identified herein and as shown on Plate 1-3 as follows:

- Area 1 – Located within Building 1063,
- Area 2 – Located north of Building 1063, and
- Area 3 – Located south of Building 1063.

The corrective action will be implemented in conformance with applicable state and federal laws and regulatory requirements including the requirements of the California Code of Regulations Title 23, Division 3, Chapter 16, Article 11, which are the primary regulations establishing the requirements and standards for petroleum-related corrective action in the State of California. Applicable regulations and requirements pertain to the protection of park resources, the handling and transportation of wastes, the control of particulate emissions and pollutants, and other construction-related activities.

The Trust will notify the Water Board, NPS, and DTSC a minimum of two weeks prior to the initiation of the corrective action implementation. All review processes will be completed before the corrective action is implemented. The Trust will review relevant aspects of the project in their N Squared Group review.

4.1 Temporary Facilities and Controls

The Remediation Contractor (ERRG) will provide and maintain the temporary facilities and controls during implementation of the corrective action implementation. These temporary facilities and controls are described in detail in the Construction Documents (*MACTEC, 2007b*) and will include, but are not limited to:

- Soil Staging Facilities and Controls
- Dust control
- Equipment Decontamination Facilities
- Personal Hygiene/Decontamination/First Aid Facilities
- Temporary Utilities and Sanitary Facilities
- Surface Drainage Controls and Erosion Control
- Survey Controls
- Preventing Spills and Leaks
- Vehicle and Equipment Fueling

- Non-Storm Water Management
- Noise Abatement and Monitoring.

4.2 Resource Protection and Safety

Because the Site is in proximity to areas known to be archaeologically sensitive, corrective action implementation will be conducted in accordance with NHPA and NEPA. Work at this Site will be monitored per the Programmatic Agreement for the Presidio between the Trust and the State Historic Preservation Officer. Work will only be performed following coordination with and approval by Trust historians and archaeologists. If items of archeologically or historically sensitive importance are found or suspected to be present, the Construction Manager and Engineering Contractor (MACTEC) will contact the Trust immediately.

Based on previous investigations conducted at the Site there are no cultural or natural resources (other than Building 1063 itself) anticipated at the Site. Through the Trust Project Manager, the corrective action implementation will be coordinated with Trust naturalists, historians, and archaeologists regarding sensitive areas that may exist at or near the Building 1065 CAP Area and take appropriate precautions during the corrective action implementation. A member of the Trust archeology group will be present at the Site as needed during the excavation activities to observe.

4.2.1 Cultural Resource Protection

Building 1063, constructed in 1941, is considered a historic structure of contributive value to the NHL and therefore, has been designated to be preserved. During the corrective action implementation at Soil and Groundwater RUs-A, every effort will be made to maintain the integrity of the building and its surroundings. Excavation activities will require the removal of the buildings supports within the area of the excavation inside the building. The Remediation Contractor (ERRG) may support the structure using a temporary support structure that will allow access to the ground surface for the removal of contaminated soils within the subsurface. Wood columns removed from the structure and the wood mezzanine will be stored within Building 1063 for potential reuse at a later date. The Trust will be apprised of all activities that affect the building, its supporting columns, or important Site features during the corrective action implementation.

Soil excavation will only be performed following coordination with the Trust historians and archeologists. If items of potential archeological or historically sensitive importance are found or suspected to be present, the Trust Project Manager will contact the appropriate Trust cultural resources points of contact immediately. If potential human remains are identified, work in the vicinity of the discovery will cease and the Trust will contact the San Francisco Coroner's Office (SF Coroner). The SF Coroner will investigate and remove the remains, if appropriate.

4.2.2 Natural Resources Protection

Soil and Groundwater RUs-A are located in an industrial/commercial area (a building and associated parking areas), and it is not anticipated that any ecologically sensitive areas/plants/animals will be present. If an animal/plant is discovered in the area that the Construction Manager and Engineering Contractor (MACTEC) suspect may be of ecological importance, they will stop work, notify the Trust, and arrange to have one of the Trust's biologists determine if work can continue or if further measures must be undertaken.

4.3 Project Health and Safety

Health and Safety Plans (HASP) (also called a Site Safety and Health Plan [SSHP]) will be prepared by the Trust's contractors for implementing the corrective action. The HASPs will be developed following federal and California Occupational Safety and Health Administration (Cal OSHA) guidelines and other local requirements. The HASPs will present a baseline program for establishing and maintaining a safe working environment during the implementation of the corrective action. The HASPs will address the hazards associated with the soil removal activities and will include an analysis of potential hazards that may be encountered by onsite workers during implementation and identify steps to mitigate the identified hazards. The HASPs will also address the reduction of potential hazards for the local public (e.g., fugitive dust, noise, traffic, etc.). The HASPs will address a multi-employer site and will include a communication plan to coordinate between employers. An on-site health and safety officer will be designated to coordinate emergency response actions. All subcontractors shall follow the HASP(s) or create their own (Trust approved) HASP for this project. The Trust's Contractors are required to submit their HASP to the Trust for review prior to mobilization to the Site. Site visitors will be required to adhere to the site HASP prepared by the Engineering Contractor (MACTEC) including restricted site access, adherence to log-in sheets, and appropriate personal protection equipment (e.g. hard hats and safety vests). Health and safety requirements for work conducted inside Building 1063 will be specified in the site HASP and will be communicated to site visitors as part of the hazard communication required before site entry.

4.4 Site Preparation

Various Site preparation activities are described below, including designation of work areas, permitting, identification of utilities, abandonment of wells, installation of a new monitoring well, and Site clearing and demolition activities.

4.4.1 Work Areas

Careful control of project activities will be performed to minimize inconvenience to the public and damage to existing structures. The excavation areas, stockpile areas, and support areas will be enclosed by an (existing) fence to prevent unauthorized access. The planned locations of excavation, stockpiling, and support areas are depicted on Plate 4-1. The Remediation Contractor (ERRG) will provide appropriate warning and other signs commonly used in conjunction with construction activities, while signs of an informational nature will be provided by the Trust.

The Remediation Contractor (ERRG) will supervise hauling and transfer operations to prevent truck traffic in unauthorized areas. Permissible traffic routes and truck staging areas are shown on Plate 4-1. Traffic control procedures will be implemented in accordance with the plan provided by the Remediation Contractor. Flaggers, cones, signs, and barricades will be used, as needed, to warn of trucks entering and exiting the work areas and to direct pedestrian, bicycle, and vehicular traffic away from moving equipment.

4.4.2 Permitting and Approvals

Permits and approvals will be obtained by the Trust and their contractors for the corrective action implementation prior to construction. The following approvals and permits are required:

- Agency approval of this Work Plan (obtained by the Trust);

- Air Board Notification from the Bay Area Air Quality Management District (BAAQMD) for soil stockpile management and dust control (obtained by the Remediation Contractor [ERRG]);
- Excavation Permit from the Trust (obtained by Trust);
- Historical/archeological and NEPA (obtained by the Trust N Squared Group); and
- Monitoring well installation, well/piezometer abandonment, and oxygen releasing product application (obtained by the Trust upon approval of this Work Plan by the Water Board).

4.4.3 Utility Clearance and Surveying

As part of the excavation permit process the Trust will contact Underground Services Alert (USA) and the Trust utility department to locate utilities in the immediate vicinity of the proposed work. Several underground utilities in the vicinity were located during previous field investigations. The Construction Manager and Engineering Contractor will coordinate identification and marking of these utilities in the field prior to beginning excavation work. No underground utilities are known to be present within the excavation areas. If underground utilities are discovered within the excavation areas during construction, they will be supported in place by the Remediation Contractor (ERRG), and the Construction Manager and Engineering Contractor (MACTEC) will stop work and will contact the Trust Project Manager and designated representative in the Trust's utility department. The Trust will identify measures to be taken regarding any utilities discovered within the excavation areas, and they will be approved by the Engineering Contractor and documented in the field report. The Remediation Contractor will resume work only upon authorization form the Trust Project Manager, Construction Manager and Engineering Contractor.

All intrusive activities will be conducted under a Trust excavation permit. The lateral extent of the proposed excavation and surrounding area will be surveyed using the NAD 1927 horizontal datum and NAVD 1988 vertical datum and stakes/markers will be placed so that accurate soil sample locations/excavation dimensions can be determined in the field. All surveys will be performed by a State of California licensed surveyor.

During excavation and grading activities, a field grid system will be established by the Construction Manager and Engineering Contractor to help locate key features at the site. The grid system will be used to locate soil samples, final excavation limits, encountered solid waste, and other pertinent features.

The Remediation Contractor (ERRG) will conduct a pre-construction topographic survey covering the areas within 100 feet of the initial excavation extents. The pre-construction survey will identify site features including roads, paths, curbs, gutters, drainage features, hydrants, trees, walls, building support columns, building floors, and fences. After the excavation is complete, the Remediation Contractor will survey the horizontal locations and vertical elevations of the excavation limits and final confirmation sample locations. The Remediation Contractor will also survey the site after the excavated area is backfilled and the site is restored.

The work areas will be mapped at the following intervals: 1) prior to trenching and excavation; 2) after the initial test trenching; 3) after the final excavation is completed (before backfilling); and 4) after the excavation backfill is completed. This will allow the accurate dimensions and depths of the trenching/excavation area to be documented during each stage of work.

The Groundwater Monitoring Contractor will survey the location and elevation of the new well installation using the datum described in Section 4.4.6.

4.4.4 Site Clearing and Demolition Inside Building 1063 (Area 1)

Portions of the existing concrete slab within the western portion of Building 1063 (Plate 1-3) will be saw cut and removed. Select building support columns will be removed, and the integrity of the roof support will be maintained through shoring. The method of shoring for the roof support will be determined by the Remediation Contractor (ERRG). Portions of the mezzanine located in the northern portion of Building 1063 may need to be removed to accommodate soil excavation. All exterior aspects of the building will be preserved and all potentially reusable wood will be saved and stored within the building.

4.4.5 Monitoring Well and Piezometer Abandonment (Areas 2 and 3)

Two existing monitoring wells and two existing piezometers are located within the planned excavation boundaries of Areas 2 and 3 and will be abandoned as part of the corrective action implementation by the Trust's Groundwater Monitoring Contractor. Monitoring wells 1065MW9A and 1065MW9B are located in Area 3 of RUs-A, south of the Building 1063 and piezometers 1065PZ1A and 1065PZ1B are located in Area 2 of RUs-A, north of Building 1063 (Plate 1-2). These wells will be abandoned in accordance with the guidelines set forth in the *Presidio-Wide Quality Assurance Project Plan, Sampling and Analysis Plan, Presidio of San Francisco, San Francisco, California* (Presidio-Wide QAPP; *Tetra Tech, 2001*) Standard Operating Procedure([SOP] SOP No. 006 Appendix A). Well abandonment will include overdrilling to approximately six-inches below the total depth of the well. The resultant borehole will be filled with a Portland cement slurry to within six-inches of the surface and finished off to match the surrounding surface. Drilling cuttings will be managed and disposed of offsite.

Wells 1065MW9A, 1065MW9B, and 1065PZ1A will not be replaced. As shown on the Time vs. Concentration Charts (Charts 4-1 and 4-2), TPHg has not been detected in groundwater samples collected from 1065MW9A and 1065MW9B since May 2004. Groundwater samples collected from piezometer 1065PZ1B have not contained TPHg or arsenic above the laboratory reporting limit in the groundwater samples collected between September 1997 and August 2005. The cleanup levels designated for the Building 1065 Area are 770 µg/L for TPHg and 10 µg/L for arsenic.

4.4.6 New Monitoring Well Installation

The Trust's Groundwater Monitoring Contractor (T&R) will replace abandoned piezometer 1065PZ1A with a new groundwater monitoring well (1065MW103A) located downgradient of Area 1 prior to excavation activities in the location shown on Plate 1-3. Monitoring well 1065MW103A will be used to monitor water levels and COCs in shallow groundwater downgradient of the excavation at Area 1 (Plate 1-3). The well will be installed and developed following the guidelines set forth in the Presidio-Wide QAPP; [*Tetra Tech, 2001*] SOP No. 004 and 005 specifically; Appendix B). Water levels are typically 5 to 6 below ground surface at the proposed well location.

The well will be constructed of 2-inch diameter 0.010 slotted casing with 2/12 sand, screened from 3 to 13 feet bgs. The well will be installed using a hollow-stem auger rig and constructed with 2-inch diameter schedule 40 polyvinyl chloride (PVC) wells. The location and elevation will be surveyed by a licensed land surveyor to within ±0.01 foot accuracy. Vertical control for groundwater elevations will be based on the Presidio lower-low water (PLLW) vertical datum. Vertical control for all other work (besides groundwater elevations) will be based on NAVD 88. The PLLW datum is 0.25 feet lower than

the NAVD 88. The well will be surveyed, developed, and sampled prior to conducting excavation activities so that a baseline for groundwater hydrocarbon concentrations and redox parameters can be obtained. The newly installed well will be placed on the quarterly groundwater monitoring and sampling schedule but will be sampled separately if it is not installed in time for the regularly scheduled sampling event. The groundwater monitoring and sampling program is summarized in Table 2-1.

4.5 Excavation Activities

Plans for the excavation of impacted soil, the installation of a groundwater sump, excavation dewatering and free product removal, application of an in-situ oxygen releasing product, and contingency actions are outlined below.

4.5.1 Initial Test Trenching Inside Building 1063 (Area 1)

Test trenches will be advanced between the support columns inside Building 1063 and will be used to estimate the final excavation dimensions prior to constructing temporary shoring and the removal of the support columns. Soil samples will be collected from the trench sidewalls and bottoms for visual inspection and soil samples will be tested for the presence of petroleum hydrocarbons using a photo-ionization detector (PID). The trench alignments may be modified in the field based on the soil screening results and visual observations of the trench sidewalls and bottoms. Soil samples will also be collected from areas that do not appear to be impacted by petroleum hydrocarbons and will be analyzed for select COCs (TPHg, TPHd with silica gel cleanup, TPHfo, BTEX, lead, and arsenic). The results of these preliminary screening samples will be used to identify which areas require further excavation. Soil samples collected from areas where select COCs are not detected during the initial sampling may be analyzed for the full analyte suite as described in Section 4.5.5, and may be used as final confirmation sidewall samples depending on the sample location and the laboratory analytical results.

Excavated soils will be stockpiled in the soil staging area outside Building 1063 (Plate 4-1) pending sampling, analysis, and disposal (see Sections 4.5.6 and 4.7).

4.5.2 Excavation of Impacted Soil – Inside Building 1063 (Area 1)

Based on the results of confirmation soil samples collected during the initial trench excavations, the Construction Manager and Engineering Contractor (MACTEC) will estimate the final dimensions of the excavation and the Remediation Contractor (ERRG) will determine the number of building support columns that will have to be removed to allow for the complete excavation of impacted soils. The Remediation Contractor will determine the best method of roof support during these operations. Any supports and or beams that are removed will be stored within the building for potential re-use within the Presidio. If supports must be removed and the mezzanine cannot be adequately shored during excavation activities, it will be dismantled (after Trust discussion and approval) and all reusable wood and building materials will be stored within the building for later reuse.

Accessible impacted vadose and smear zone soils within the excavation area will be removed within the limits shown on Plate 1-3. Cross-Section A-A' (Plate 4-2) shows the expected soil types and thickness along a north/south line through Building 1063. Confirmation soil samples will be collected from the excavation sidewalls and bottom as described in Section 4.5.5. The analytical results of confirmation soil samples will be compared to the cleanup levels to assess if further excavation is necessary. Professional judgment will be used to determine how much additional soil will be over-excavated in the vicinity of the confirmation soil samples with COCs detected at concentrations above cleanup levels. The size of the

over-excavation will be based on the magnitude of the exceedance relative to the cleanup level, the results of field monitoring (if applicable to the COC), as well as other observations made in the field such as soil discoloration, soil type, olfactory evidence, extent of debris, etc. The Trust, Water Board, NPS, and DTSC will be consulted regarding over-excavation decisions.

Confirmation samples will be collected from the over-excavated area at the same frequency as the confirmation soil samples that were collected from the initial excavation. At a minimum, one bottom and three perimeter samples will be collected from the over-excavated area. Samples collected from the over-excavation will be analyzed for the COCs associated with the chemical(s) that exceeded cleanup levels in the initial confirmation soil sample.

Building 1063 is a historical structure and corrective action implementation inside the building requires approval from the Trust's N Squared Group. The extent of the excavation will be laterally confined by the building walls and by the roof support columns. The Trust's N Squared Group has approved the roof support columns be removed inside the building in the area where the partially below-grade water tank will be installed as part of the future treatment plant. If it becomes necessary to excavate to those boundaries, confirmation samples will be collected from the sidewalls and bottom of the excavation to document the residual contamination that may be left in-place. Soil will be excavated to a depth of approximately 8 feet bgs. The excavation will not extend vertically more than one foot into the Bay Mud, which inhibits migration of contaminants.

It should be noted that, based on soil sampling performed to date, contaminated soil is not expected to be present outside the planned excavation area shown on Plate 1-3.

Historical fill used in some areas of the Presidio has been known to contain metal concentrations that exceed cleanup levels. Based on analytical results of soil samples collected beneath the former Building 1065 (adjacent to the Site), metal concentrations are generally below cleanup levels (*MACTEC, 2004b*). However, the potential still exists that there may be metals exceedances in large areas of the historic fill. A LUC may be implemented for soil containing COCs above cleanup levels that cannot be removed by excavation.

4.5.3 Excavation of Impacted Soil – Outside Building 1063 (Areas 2 and 3)

The proposed excavation in Area 2 of Soil and Groundwater RUs-A is north of Building 1063, as shown on Plate 1-3. Soils at and between piezometers 1065PZ1A and 1065PZ1B (which will be abandoned prior to excavation in Area 2) and soil boring location 1065SB115 will be excavated to at least 6 feet bgs to remove vadose and smear zone soils in that area. The proposed excavation in Area 3 of Soil and Groundwater RUs-A is south of Building 1063, as shown on Plate 1-3. Soils at and between soil boring location 1065SB135, groundwater monitoring wells 1065MW9A and 1065MW9B (which will be abandoned prior to excavation in Area 3), and the Phase I IA trench sample 1062EX115 will be excavated to at least 6 feet bgs to remove vadose and smear zone soils in that area.

Soil samples will be collected from the excavation sidewalls and bottoms in Areas 2 and 3 for visual inspection and soil samples will be tested for the presence of petroleum hydrocarbons using a PID. The excavation will not extend vertically more than one foot into the Bay Mud, which inhibits migration of contaminants. If soil contamination is present under the building foundation, limited trenching under the building foundation may occur. Impacted soils will be identified by staining, odor, and/or PID readings. Soil confirmation samples will be collected as described in Section 4.5.5.

Additional excavation may be required based on the results of soil confirmation sampling. The Construction Manager and Engineering Contractor (MACTEC) will communicate with the Trust regarding the need for additional excavation. The Trust will coordinate with the stakeholders including the Water Board, NPS, and DTSC regarding the excavation progress, results of confirmation samples, and recommendations to over-excavate by holding weekly meetings, or more frequent meetings as needed (See Section 6.4).

Excavated soils will be stockpiled in the soil staging area (Plate 4-1) pending sampling, profiling, and disposal (Sections 4.5.6 and 4.7).

Excavation Areas 2 and 3 may be excavated during the initial trenching activities of Area 1 or may occur before or after the excavation activities in Area 1 inside Building 1063 at the discretion of the Remediation Contractor (ERRG) in discussions with the Trust and the Construction Manager and Engineering Contractor (MACTEC).

4.5.4 Excavation Dewatering and Free Product Removal

Soil will be excavated below the static groundwater level that is estimated to be between 3.5 and 5 feet bgs. Once the excavation reaches this depth, groundwater will need to be removed from the excavation to allow continued digging to the excavations final depth. The Remediation Contractor (ERRG) will control any groundwater flowing toward or into the excavation to prevent the sloughing of the excavation slopes and walls and to eliminate interference with the orderly progress of excavation. French drains, sumps, ditches or trenches will not be permitted within 3 feet of the foundation of any structure, except with specific written approval, and after specific provisions for the restoration of the foundation area have been made. Control measures shall be taken by the time the excavation reaches the water level in order to maintain the integrity of the in-situ material.

If free product is present, the Remediation Contractor will use absorbent pads and/or booms to remove free product floating on the groundwater surface prior to diverting or pumping the water into an onsite storage tank and/or discharging the water into the sanitary sewer. The absorbent pads and/or booms will be stored in drums and disposed of as hazardous waste. If large volumes of free product are encountered, a vacuum truck will be used to vacuum up the floating product prior to groundwater dewatering.

Water removed from the excavation will be collected in high-volume storage tanks outfitted with baffles to contain sediments. The water tank holding system will be designed and set up to achieve steady state conditions, and the Construction Manager and Engineering Contractor (MACTEC) will collect water samples to be analyzed in accordance with the Trust's industrial wastewater permit issued by the City of San Francisco Publicly Owned Treatment Works (POTW) to confirm the discharge requirements are met (Table 4-1). The Remediation Contractor (ERRG) will coordinate with the Trust's utility department regarding discharge of water generated during dewatering activities.

4.5.5 Confirmation Soil Sampling

Soil confirmation samples will be collected from the excavated areas in Areas 1, 2, and 3 to document soil remaining in the excavation sidewalls and bottom samples does not exceed cleanup levels. Additional excavation may be required based on the results of soil confirmation sampling. The Construction Manager and Engineering Contractor (MACTEC) will communicate with the Trust regarding the need for additional excavation. The Trust will coordinate with the stakeholders including the Water Board, NPS, and DTSC regarding the excavation progress, results of confirmation samples, and recommendations to

over-excavate by holding weekly meetings, or more frequent meetings as needed (See Section 6.4). Confirmation soil sampling and analysis procedures are described below.

Confirmation Soil Sampling Frequency:

Soil samples will be collected from the excavation "bottom" and along the "sidewalls." Bottom sampling will be based on the estimated size of the excavation with a minimum of one sample per 625 square feet (sf) (25 feet by 25 feet). Sidewalls will be sampled at the midpoint of the height of the sidewall (using best professional judgment for biasing sample location to any visible stained soil layers) every 25 feet of its lateral extent or to obtain at least one sample per excavation sidewall. The actual physical dimensions of the excavation will determine the number of bottom and sidewall samples collected. At least one bottom and four sidewall samples will be collected from each excavation.

Confirmation Soil Sampling Methods:

Confirmation soil samples will be collected in accordance with the Presidio-Wide QAPP, specifically SOP No. 001 (*Tetra Tech, 2001*). Soil samples to be analyzed for non-volatile compounds will be collected in clean brass, stainless steel, or butyrate sleeves, covered with Teflon® sheets and plastic end caps, and labeled. Liners will be driven into the sidewall or bottom of each excavation, or into a backhoe bucket containing soil from the target sample location. Samples collected for VOCs will be collected in Encore samplers. For Encore samples, a hand sampler will be driven next to the location of the tube sample. If the soil is composed of pieces of debris, gravel, or very coarse sand that contains void spaces or if rock clasts or debris fragments are larger than the diameter of the Encore sampler, the Encore sampler will not be used and soil samples collected for VOCs analysis will be collected in the stainless steel tube. Samples will be stored in an ice-cooled chest for transportation to a state certified laboratory under chain-of-custody protocols. Each ice-cooled chest will maintain a sample temperature of 4°Celsius (C; ±2°C). If sample analysis is to be delayed or put on hold, the Encore samples will be frozen in the laboratory to prevent the possible loss of VOCs before analysis.

Sample Identification and Labeling:

A sample label will be attached to each sample container. The label will be completed in indelible ink with the project name and Site number, a unique identification number, date and time collected, initials of the sampler, and analyses required. Confirmation sample identification will be conducted in accordance with the Presidio-Wide QAPP. Confirmation samples will be identified as follows:

- Site (Building/Location) number (1065),
- Sample type (e.g., EX=excavation),
- Sequence number (e.g., 301, 302, 303,…) for confirmation samples, and
- Depth in feet below ground surface (e.g., 4.5).

For example, the 4th confirmation soil sample, collected at 6 feet bgs will be labeled as 1065EX304(6). Prior to commencement of sampling activities, the Construction Manager and Engineering Contractor will contact the Trust Environmental Database Manager to confirm that soil sample identification numbers utilized during the corrective action implementation are unique to the Presidio.

Quality Assurance/Quality Control (QA/QC) Samples:

The following QA/QC samples will be collected:

- ***Equipment Rinsate Samples.*** Equipment rinsate blanks will be collected daily by running distilled water over each sampling device used. Per the Presidio-Wide QAPP, equipment rinsate blank identification will be derived by combining the following symbols: the identification number of the sample collected before the blank, the identifier "RB", and a shortened identification of the sample collected after the blank (e.g., a rinsate blank collected after location collected after location 1065EX301 and before 1065EX302 would have a designation of 1065EX301RB302).

- ***Field Duplicate Samples.*** Per the Presidio-Wide QAPP, field duplicate samples will be collected at a frequency of one for every 10 samples of the sample matrix. Field duplicate samples will be labeled DUP plus the date (i.e., DUP100806 would represent a duplicate sample collected on October 8, 2006). If more then one field duplicate is collected on the same date, a suffix (i.e., "-1" or "-2") will be used to maintain unique sample identification numbers.

- ***Matrix Spike/Matrix Spike Duplicate (MS/MSD) Samples.*** Per the Presidio-Wide QAPP, MS/MSD samples will be identified using the primary field sample location identification plus "MS" or "MSD" (i.e., 1065EX301MS or 1065EX301MSD). One MS/MSD sample will be collected per every 20 samples of the same matrix.

Chain-of-Custody Records:

Chain-of-custody records provide an accurate written record that tracks the possession of individual samples from the time of collection in the field until they are accepted at the laboratory. The chain-of-custody record also will be used to document the samples collected and the analysis requested. The Construction Manager and Engineering Contractor will record the following information on the chain-of-custody record: Project name and number; name and signature of sampler; destination of samples (laboratory name); sample identification number; sample location, description, and depth (where applicable); date and time of collection; number and type of containers filled; analysis requested; preservatives used (if applicable); filtering (if applicable); signature of individuals involved in custody transfer (including the date and time of transfer); laboratory purchase order number; air bill number (if applicable); and relevant remarks related to sample analysis (such as samples selected for MS/MSD analysis).

Per the Presidio-Wide QAPP requirements, a copy of the chain-of-custody record will be delivered to the Trust Project Manager as soon as possible after sampling. An example chain-of-custody record is included in Appendix C.

Confirmation Soil Sampling Documentation:

Confirmation sample locations will be sketched in the field notes. Confirmation sample locations that meet cleanup levels will be accurately mapped with the limits of the excavation.

For all samples collected at the Site, sample tracking documents will be prepared so that chain-of-custody records can be maintained and sample disposition can be controlled. Sample identification documents will include a Daily Field Log, a sample label, and chain-of-custody records. The Construction Manager and Engineering Contractor will prepare these records during each sampling activity. Soil confirmation

sample locations will be surveyed in the field. Section 6.1 describes the content of the Daily Field Log that will be prepared specific to the project, and a chain-of-custody record is included in Appendix C.

Confirmation Soil Sampling Analysis:

Confirmation soil samples collected from the excavations in Areas 1, 2, and 3 will be analyzed for the following COCs:

- PAHs by EPA Method 8310 or 8270-SIM;
- TPHg by EPA Method 8015 modified;
- TPHd and TPHfo by EPA Method 8015 modified, prepared with Silica Gel Cleanup, EPA Method 3630A;
- VOCs (including BTEX and 2-hexanone) by EPA Method 8260B; and
- Title 22 Metals (including arsenic, cadmium, lead, and zinc) by EPA 6000-7000 series.

Data Validation and Data Management:

The Construction Manager and Engineering Contractor will obtain analytical data directly from the laboratory and will perform a cursory review of the chemical data (EPA Level II validation) and QA/QC data prior to consulting with the Trust and agencies regarding the need to continue excavation or begin backfilling. The purpose of the cursory review is to identify any significant QC failures or elevated detection limits that would affect decisions regarding whether the data are sufficient to show that COCs are not present in confirmation soil samples at concentrations greater than cleanup levels. Preliminary analytical data will be screened against cleanup levels and cleanup level exceedances identified. Tables of preliminary data will be prepared and presented in weekly stakeholder meetings.

Level III and Level IV data validation will be performed after hard copies of the raw data packages are received from the laboratory. Validation will be performed and qualifiers will be applied to analytical results in accordance with the Presidio-Wide Quality Assurance Project Plan, US Environmental Protection Agency Contract Laboratory Program National Functional Guidelines for Organic Data Review, and US Environmental Protection Agency Contract Laboratory Program National Functional Guidelines for Inorganic Data Review. The results of the Level III and Level IV data validation will be presented in the Construction Completion Report.

Pertinent chain of custody information and analytical data (obtained electronically from the laboratory) will be loaded into MACTEC's database and the Presidio's data base. Survey data (northing and easting coordinates) for the confirmation samples and data validation qualifiers will also be loaded into both data bases. Database reports of Level III validated analytical data will be generated from MACTEC's database for presentation in the Construction Completion Report.

4.5.6 Soil Stockpiles

Plate 4-1 shows the area where the soil removed from the excavations will be stockpiled prior to profiling and disposal. The actual location of the final stockpiles will be determined by the Trust and the Remediation Contractor (ERRG). Soil stockpiles will remain covered at all times when not actively being used.

To facilitate the quick and efficient removal of stockpile soils, the Remediation Contractor will profile the waste in accordance with offsite disposal facility requirements and will fill out waste profiles and submit profiles and backup materials (e.g., test results and sampling method) to the Trust for review at least five days prior to scheduled loading for offsite disposal. The Remediation Contractor will determine the location/method of disposal based on waste profile results. Material will be removed from the Presidio and disposed of or recycled offsite. Onsite is defined as within the temporary fenced construction areas. Disposal options will be determined by the Remediation Contractor in consultation with the Trust and regulatory agencies, as appropriate. Recyclable materials transported offsite will be surface-cleaned using dry methods (such as a broom), and transported and disposed of offsite as appropriate.

All truckloads must be covered at all times from the point of departure at the Site to arrival at the disposal facility. The transportation route is shown on Plate 4-1. It is unacceptable for waste or potentially contaminated material to be tracked by truck tires offsite. The Remediation Contractor will control tracking of soil and mud onto streets and clean streets as needed.

4.5.7 Application of In-Situ Oxygen Releasing Product

The purpose of applying an oxygen releasing product to the excavation bottoms at RUs-A is to remediate residual petroleum hydrocarbons: (1) that may be left in place in saturated soils at RUs-A, and/or (2) are present in groundwater. It is possible that due to structural constraints in the three excavation areas posed by the presence of the foundation, walls, or footings of Building 1063, soil removal may be impracticable for over-excavation. Accordingly, some petroleum hydrocarbon-impacted saturated soils will be left in place. An oxygen releasing product may be used to stimulate aerobic bioremediation of petroleum impacted soils and groundwater.

Appendix D (Application of Oxygen Releasing Product in Excavations) presents a detailed summary of the assumptions and basis for oxygen releasing product application, including the basis for modifying the application quantity once the excavation is sampled, as well as the decision-making criteria for not applying an oxygen releasing product. Appendix D also summarizes the "lessons learned" from application of oxygen releasing products at the Building 637 CAP site (*EKI, 1999a, 1999b, 2000, 2004*) to assist the Trust in evaluating the proper application and monitoring requirements at RUs-A located within and adjacent to Building 1063.

ORC Advanced ™ is proposed for application within excavations at RUs-A at the quantity recommended by Regenesis in their *Letter Proposal*, dated January 25, 2007 (see Appendix D Attachment). The proposed application design is labeled in the proposal as "preliminary" in order to allow for flexibility in adapting the design based on additional data that will be collected between the date of publication of this Work Plan, and the initiation of construction activities (excavation and source removal).

The proposed ORC Advanced™ application quantity to be applied at the bottom of the excavations at RUs-A is based on the following site-specific data at RUs-A:

1) Weight of soil; and

2) Type of soil.

Regenesis based their recommended application quantity on the estimated weight of the soil and the type of soil in the saturated zone of the RUs-A for the Area 1 excavation. The evaluation was conducted for Area 1 because this area: (1) is the largest of the three excavation areas, (2) has the highest concentrations and deepest detections of petroleum-related COCs within the saturated zone, and (3) is

considered the primary source area of petroleum-related contamination within RUs-A. The quantity of ORC Advanced ™ recommended for residual soil contamination is:

- 13,800 ft^3 (estimated volume of petroleum-impacted soil potentially left in place) x 0.44 lbs/ft^3 (110 pounds (lbs)/cubic foot (ft^3)) of soil x 0.004 (0.4 percent ORC Advanced ™) = approximately 6,000 lbs of ORC Advanced ™

The proposed quantity of ORC Advanced ™ is the quantity that would need to be applied under "worst case" conditions (i.e., the residual COCs in saturated soil are the maximum concentration of COCs observed at the site). The actual quantity of ORC Advanced ™ can be adjusted based on confirmation soil sample results. Excavation followed by confirmation soil sampling may indicate the excavation is clean (i.e., no COCs are detected above cleanup levels), or that low levels of residual petroleum contamination remain in the excavation.

Due to structural constraints in the excavation areas posed by the presence of the foundation, walls, or footings of Building 1063, soil may be left in place at concentrations exceeding cleanup levels. For example, the excavation inside Building 1063 may be implemented in increments where soil is strategically removed around the existing columns then backfilled before moving to the next excavation. In this case, if the confirmation soil samples indicate COCs are present, ORC Advanced ™ may need to be applied to the excavation bottom before the excavation is backfilled. Another scenario where the quantity can be modified is if COCs are present in the saturated soils in Areas 2 and 3. It is currently not anticipated that petroleum-related COCs are present below the water table in these areas. The following application quantity is proposed to allow for these possible conditions:

- 6,000 lbs/3,000 ft^2 = approximately 2 lbs of ORC Advanced ™ /ft^2 of impacted soil.

The oxygen releasing product will be placed in the excavations using a method that is consistent with the manufacturer's recommended application guidelines identified in Appendix D. The Remediation Contractor (ERRG) will prepare a 50 percent slurry by adding three gallons of clean water to every 25 pounds of ORC Advanced™ product. The Remediation Contractor will thoroughly mix the oxygen releasing product with water using a hand held drill and a stucco mixer or equivalent. The slurry will be spread evenly across the bottom of the excavations within 15 minutes of mixing the product and water at the indicated coverage using either a high volume, low-pressure pump or an excavator bucket.

The newly installed monitoring well 1065MW103A will be used to monitor baseline groundwater conditions prior to excavation, and to monitor the effectiveness of the oxygen releasing product in reducing petroleum-related COC concentrations after the soil is excavated and the excavations are backfilled. As summarized in Table 2-1, petroleum-related COCs TPHg and BTEX, arsenic, and aluminum, iron, manganese, redox parameters and field parameters will be monitored in groundwater before and after application of oxygen releasing product to: (a) assess the effectiveness of source removal and application of oxygen releasing product (if applied) in excavations at reducing residual petroleum contamination in groundwater; (b) verify COC concentrations in groundwater are not migrating offsite; and (c) assess whether concentrations of COCs and arsenic and redox parameters in wells and piezometers at the Site show trends over time.

The indicator parameters identified in Table 2-1 will help identify if the application of ORC Advanced™ within the saturated zone of the excavations is providing sufficient oxygen to stimulate aerobic biodegradation of petroleum hydrocarbons in saturated soils and groundwater. As described in Appendix D, based on previous oxygen releasing product applications at the Building 637 CAP Site, these parameters will be adequate to evaluate the effectiveness of the oxygen releasing product. The oxygen

releasing product is expected to begin releasing oxygen immediately upon introduction into the water column and to continue to release oxygen for a period of approximately one year.

Additional application of in-situ oxygen release product via in-situ injection may be considered if groundwater monitoring data indicates the excavation of contaminated soil and the initial application of in-situ oxygen release product within the excavation has not reduced groundwater COCs to concentrations below cleanup levels within 18 months of application. If results of groundwater monitoring indicated concentrations of COCs exceeds cleanup levels approximately 18 months after the oxygen releasing product is applied, the effectiveness of the oxygen releasing product will be evaluated by the Engineering Contractor (MACTEC), and the stakeholders will be consulted in regards to the possible injection of additional oxygen releasing product. A technical memorandum will be prepared that summarizes the water quality data, and may provide recommendations for further oxygen releasing product application, if needed as described in Section 7.0 of this Work Plan.

4.5.8 Contingency Actions

To minimize disruptions to the work, the following contingency actions have been developed. These situations are not expected to occur. However, it is prudent to plan for their potential occurrence and take reasonable measures in advance in order to be able to implement these actions quickly in the event that they become necessary.

USTs and Associated Piping: Although not anticipated, if the corrective action uncovers a previously unidentified UST and/or associated piping, the Trust will comply with applicable State and local regulations for UST and/or associated piping removal. If encountered, the Remediation Contractor (ERRG) will stop work and the Construction Manager and Engineering Contractor (MACTEC) will contact the Trust. The Remediation Contractor shall continue work in other parts of the Site. The Trust will obtain the appropriate removal permit from the County and/or hire an appropriate environmental contractor to remove the UST and/or associated piping, and any associated petroleum hydrocarbon-impacted material, under City and County of San Francisco Department of Public Health and San Francisco Fire Department oversight in accordance with standard procedures at the Presidio. The Remediation Contractor will resume work only upon authorization form the Trust Project Manager, Construction Manager, and Engineering Contractor.

Pipelines: In the event that an underground utility pipe is found during the performance of the excavation work, the Remediation Contractor (ERRG) will determine if the line is active or inactive. If the line is an active utility, all attempts will be made to support the utility during the excavation activities and maintain its integrity. If the line is determined to be inactive, the Remediation Contractor will remove the pipeline. If the pipeline is identified as a conduit for petroleum hydrocarbons associated with a UST or if contamination is identified by staining, odor, and/or PID readings, the Remediation Contractor will remove as much of the pipe as possible.

Drums or Other Containers: In the event that drums or other containers containing liquids are found during the performance of the excavation work, the Remediation Contractor (ERRG) will stop work and contact the Trust. The Remediation Contractor may continue work in other parts of the Site. If encountered, the contents of the drums or container will be sampled by the Trust and the drums or containers will be handled in accordance with the Site-specific HASP and all applicable laws and regulations. The Trust will coordinate removal of the drum or other containers with an appropriate environmental contractor hired by the Trust if the drums are found to contain or have contained a hazardous material. The Remediation Contractor shall assist the Trust as directed in accordance with standard procedures at the Presidio. If the drums or other containers are found to not have contained a

hazardous material, the Remediation Contractor shall remove the drums at the Trust's direction in accordance with standard procedures at the Presidio. Drums or other containers removed from the Site will be placed in lab-packs, overfill drum, or other suitable containers for transportation and off-site disposal if necessary.

Asbestos-Containing Materials: The presence of asbestos containing materials (ACMs) is considered unlikely at the Site. In the event that ACMs are found during the performance of the excavation work, the Remediation Contractor (ERRG) will stop work and will contact the Trust. The Remediation Contractor may continue work in other parts of the Site. ACM will be handled in accordance with the Site-specific HASP and all applicable laws and regulations, as well as any applicable requirements of the Presidio's Asbestos Operation and Maintenance Program (*HES, 2000*). The Trust will coordinate removal of the ACM with an appropriate environmental contractor hired by the Trust. The Remediation Contractor shall assist the Trust as directed in accordance with the Presidio's Asbestos Operation and Maintenance Program.

Unexploded Ordnance: It is unlikely that any unexploded ordnance (UXO) will be found within, or in the vicinity of, the Site. However, UXO has been discovered in other unexpected locations at the Presidio. Therefore, the Remediation Contractor (ERRG) will be advised of this possibility, and guidelines for recognizing UXO will be attached to the project-specific HASP. These guidelines will be consistent with the Trust's policies regarding potential UXO discovery procedures. If UXO is discovered during the course of the work, the Remediation Contractor will cease work in the affected area; remove personnel from the affected area, and the Construction Manager and Engineering Contractor (MACTEC) will contact the Trust Project Manager, who in turn will coordinate a response with Park Dispatch and all other interested parties. The Remediation Contractor will resume work only upon authorization from the Trust Project Manager, Construction Manager, and Engineering Contractor.

4.6 Backfill and Grading

Prior to backfilling the excavation, the Remediation Contractor (ERRG) will document the final lateral dimensions and depths of the excavation area using the surveyed markers set up before the excavation work (Section 4.4.3). In addition to the maximum extent of excavation, encountered utilities, soil types, and other notable features will be documented and reported in the Construction Completion Report.

Following Engineering Contractor approval that the excavation limits have been achieved and final excavation dimensions have been mapped, the Remediation Contractor will backfill the excavations with imported fill materials. The Remediation Contractor will inspect imported fill sources and the Construction Manager and Engineering Contractor will collect samples for laboratory analysis to identify the potential presence of COCs and other chemicals before the fill is brought to the Site. Sample collection and QA/QC procedures will be in accordance with the Presidio-Wide QAPP. Import fill material will be sampled at each fill source at a frequency and analytical suite consistent with DTSC guidance (*DTSC, 2001*) and Water Board Order No. R2-2003-0080. For import soil volumes greater than 5,000 cubic yards, this frequency consists of 12 composite samples for the first 5,000 cubic yards and one additional composite sample for each additional 1,000 cubic yards. Samples will be analyzed for (at a minimum) TPHg, TPHfo, TPHd, and BTEX using EPA Test Method 8015 and Title 22 metals using EPA Test Method 6010C plus 7471A for mercury. If the proposed backfill material is from an agricultural source, samples will also be analyzed for pesticides and herbicides by EPA Methods 8081A, 8141A, and 8151A. Additional analyses may be required based on the borrow source. Chemical concentrations detected in samples of potential imported fill will be compared to the Site soil cleanup levels and requirements for backfill material specified in the Water Board Order No. R2-2003-0080. Soil with

chemical concentrations above soil cleanup levels and the requirements of the Water Board Order No. R2-2003-0080 will not be accepted for import to the Site.

The Presidio has two potential soil borrow sources that may be used for excavation backfill, in addition to any gravel and/or roadbase that may be required (obtained from an offsite quarry). These potential onsite sources include a small quantity (10-20 cubic yards) of dune sand from Golden Gate Park that is located near the Phase I Interim Action at the former Building 1065 and soil from the Lucas excavation that is located at Building 67.

The area inside Building 1063 is scheduled to undergo further excavation and construction in order to place the water tanks needed for the water recycling plant. The excavation inside the building will be partially backfilled using gravel and/or sand. This will allow for stability of the soil but will also be easy to remove at a later date. The final elevation below ground surface of the backfill materials will be decided by the Remediation Contractor (ERRG) (in discussions with the Trust, Construction Manager, and Engineering Contractor [MACTEC]) and will be based on excavation stability, future excavation plans, and building support.

The Remediation Contractor will place aggregate drain rock in the bottom of the excavation as needed. In Areas 2 and 3, outside Building 1063, the Remediation Contractor will place a layer of non-woven geotextile fabric above the aggregate drain rock and will use imported fill to backfill the excavation above the geotextile fabric and below pavement or unpaved area subgrade elevations. Backfill material will be placed in loose lifts less than eight inches thick and compacted to at least 90 percent of the maximum dry density as determined by ASTM D 1557 greater than 2 feet below pavement subgrade elevation. Backfill materials placed less than two feet below pavement grade will be compacted to at least 95 percent of the maximum dry density as determined by ASTM D 1557. The Construction Manager and Engineering Contractor will observe placement and compaction of the backfill material and the Remediation Contractor will perform density tests at representative locations to confirm that adequate compaction is obtained.

The final dimensions of the backfilled excavation will be surveyed to within ±0.1 foot accuracy as described in Section 4.4.3.

The northern excavation area (Area 2) will be paved to match the surrounding surface. The southern excavation area (Area 3) will be backfilled to grade and will not paved with asphalt. All outside areas will be sloped to allow for proper drainage.

4.7 Loading, Off-Haul, and Disposal of Soil

As described above, analytical results from stockpile sampling will be used to profile excavated soil for disposal at an offsite permitted landfill facility. The actual volume of soil that will be transported and disposed offsite will depend on the results of confirmation sampling that will indicate the need for and amount of over-excavation.

The decision whether to dispose contaminated soils at a Class 1, 2, or 3 landfill will depend on the mixture of contaminants and associated concentrations measured in the excavated soil. The excavated soil is anticipated to be acceptable at a Class 2 or 3 landfill; no Class 1 material is anticipated. After soil profiling is completed and an appropriate landfill facility is identified to accept the soils, stockpiled soil will be loaded into lined dump trucks and transported by a licensed, Department of Transportation (DOT)-approved transportation contractor under hazardous waste manifest or bill of lading (whichever is appropriate), directly to the disposal facility. The disposal facility will provide a certificate of receipt for

each load of material as well as a weight receipt for each truckload. Hauled materials will be fully covered during transport and at the end of each workday. Copies of the certificates of receipt will be provided to the Trust with the Remediation Contractor's (ERRG's) submittals.

The haul route for transport of excavated soil offsite is shown on Plate 4-1.

4.8 Site Restoration

Once the excavations have been backfilled as described in Section 3.7, the Remediation Contractor will remove remaining solid waste generated for the corrective action implementation, and dismantle and remove temporary facilities constructed or mobilized for the project. Temporary shoring of the column supports may be left in place, the support columns may be replaced with new longer support columns and new concrete piers or similar foundation, or the existing support columns may be put back in place and temporary supports built. The final decision will be based on discussions between the Remediation Contractor (ERRG), the Trust, the Construction Manager, and the Engineering Contractor (MACTEC).

5.0 LAND USE CONTROLS FOR REMEDIAL UNITS A AND C

A LUC will be implemented for residual contamination in soil or groundwater at the Site that contains concentrations of COCs above cleanup levels identified in Tables 1-1 and 1-2, respectively, after implementation of corrective actions have been completed. It is anticipated that the LUC associated with Groundwater RU-A will be lifted after corrective actions are completed when groundwater monitoring shows concentrations of petroleum-related COCs and arsenic are below cleanup levels for four consecutive sampling rounds. Although not anticipated, a LUC may be implemented for Soil RU-A if soils containing COCs above cleanup levels cannot be removed due to structural limitations inside Building 1063 (as described in Section 4.5.2). In addition, a LUC will be instituted for Soil RU-C consistent with the current and future reuse of this historic building that will be preserved and potentially occupied in the future. As described in the CAP (*MACTEC, 2007a*), the northwestern portion of the Building 1040 foundation will serve as a cap to isolate contaminated soil from exposure to potential receptors. Section 2.3 describes how the corrective action for Soil RU-C will be implemented, as well as the reporting and responsibilities of the Trust and their contractors. The foundation and adjacent area will be inspected and improvements will be made (e.g., sealing the flooring and any conduits to the subsurface, monitoring indoor air quality) to prevent occupant exposure to volatile COCs in vadose zone soils that may intrude into the building. Because the contaminated soil will not be removed, a LUC will be implemented to safeguard and maintain the cap, provide advance notice of Site conditions in the event of future ground disturbing activity, and restrict future land uses to those compatible with safeguarding the integrity of the cap.

LUCs refer to administrative restrictions on the potential future use of land based on the levels of contaminants that may be left onsite at concentrations greater that allow for unrestricted use. The Trust generally does not consider LUCs by themselves to meet the cleanup goals for sites where contaminated materials remain left in-place and potentially exposed. LUCs restrict future site use and future site activities in order to limit exposure to COCs left in place or to ensure the effectiveness of the selected site remedy. The Building 1065 Area RUs are located in Area B of the Presidio. Existing and planned land uses in Area B are directed by the Trust through its comprehensive land use and management plan, the Presidio Trust Management Plan (PTMP) (*Trust, 2002*). LUCs in Area B are managed in accordance with the Trust's LUCMRR (*Trust, 2006*).

The LUCMRR serves as the Trust's overall implementation and enforcement plan to meet the requirements of State of California requirements and §5.11 of the Consent Agreement (*DTSC, 1999*). The LUCMRR provides the framework to LUC management in Area B and describes the procedures the Trust will use to track, implement and enforce LUCs at remediation sites in Area B where LUCs are part of the selected remedy. For each individual site identified as requiring a LUC, a site-specific addendum to the LUCMRR will be prepared. Each site-specific LUCMRR addendum will include a figure depicting the site location and nearby area, and will summarize the site history, the specific COCs encountered at the site, the actions taken to remediate the site, the in-place management system (such as containment), the levels and general locations of COCs remaining at the site that required the implementation of the LUC, and site-specific restrictions for that LUC area. In addition, these site-specific addenda will discuss restricted or prohibited land uses at the site and any special requirements (e.g., health and safety requirements) if the area is disturbed in the future.

The Site-Specific Addendum to the LUCMRR for the Building 1065 CAP Area will be included as an addendum to the Construction Completion Report, and the location of the LUC will be added to the Trust's Geographical Information System (GIS) system that serves as an informational database for all

remediation sites with LUCs in Area B of the Presidio. The LUCMRR identifies the content requirements of site-specific addenda. Documentation procedures are described in Section 7.0 of this Work Plan; the project team responsibilities associated with this corrective action are summarized in Table 3-1; and the scheduling associated with this corrective action is shown on Plates 8-1a and 8-1b. As a federal agency, the Trust is required under NEPA to consider the potential environmental impacts of any project, plan, program, or action at the earliest stage of planning and before implementation. The Trust carries out this obligation using a project review process that screens proposals for compliance with Trust N Squared Group, and other such laws and regulations. The Trust's N Squared compliance process screens every proposed action in Area B at the Presidio (e.g., fence post installation, tree trimming, native plant restoration, building renovation, and building demolition). The Trust N Squared Group compliance process (i.e., project review program) is a first step to insure that Trust staff is aware of known contamination and associated LUCs in the vicinity of project sites. This review process, by scrutinizing the attributes of the project site and the proposed action, can be used to alert Trust staff to known and remediated hazardous substance sites, as well as LUCs.

In addition, for any Area B project involving construction, excavation, or subsurface work, the Trust requires not only Trust N Squared Group clearance but also a building/project permit. For any project, the permit process requires Preliminary Design, Preliminary Plan Review, Design Development, and Permit Plan Review and approval. Here too, at the earliest stage of project planning, the Trust Project Manager, tenant, or user is provided with an information checklist with key information about the project site, including any LUCs. The Trust will use its project permit process to notify and require adherence by project proponents to any LUC restrictions and requirements. Both the Trust's project review and project permitting programs will include a link (i.e., in both the standardized Trust N Squared Group project screening form and the project permit checklist) to the Trust's GIS system containing complete LUC site information.

In general, LUCs in Area B of the Presidio are intended to fulfill the following goals:

- Maintain protection of human health and the environment;
- Prevent inappropriate land use of the property containing residual contamination in soil or groundwater;
- Assure that information about the property containing residual contamination in soil or groundwater is available to the local government or the public;
- Ensure that long-term mitigation measures and monitoring requirements are carried out and maintained;
- Ensure that the integrity and stability of the remedy (implemented corrective action alternative) is maintained;
- Ensure that subsequent property owners or transferees have a duty to assume any responsibility for requirements or restrictions pertaining to the residual contamination in soil or groundwater when the property is transferred; and
- Ensure that appropriate regulatory agencies will be contacted prior to a change in land use or change to the selected remedy.

When LUCs are implemented at the Building 1065 Area, the Trust will undertake the procedures below to ensure that the appropriate LUCs are adhered to by present and future owners and users of the Site:

- Prepare a Site-Specific Addendum to LUCMRR – This site-specific addendum to the Trust's LUCMRR will be specific to those portions of the Building 1065 Area where LUCs are incorporated into the selected remedy. A single site-specific LUCMRR addendum will be prepared to address Building 1065 Area LUCs, and will be included as an addendum to the Construction Completion Report. The LUCMRR addendum will include figures depicting actual areas where LUCs are being applied at each RU, a summary of the site history, the specific COCs encountered at each RU, the actions taken to remediate each RU, the in-place management system (such as containment), the levels and general locations of COCs remaining at each RU that necessitated the implementation of the LUC, and site-specific restrictions for that LUC area. In addition, these site-specific addenda will discuss restricted or prohibited land uses at the site and any special requirements (e.g., health and safety requirements) if the area is disturbed in the future. The Site-Specific Addendum to the LUCMRR for the Building 1065 Area will be submitted to stakeholders including the Water Board, NPS, and DTSC.

- Project Permit Process – In advance of implementation, all Trust plans and projects in the vicinity of the Building 1065 Area will be screened by the Trust N Squared Group process and Excavation Clearance Permit ("dig permit") process. Planning/project proponents will be notified of the LUCs specific to the Building 1065 Area. The Trust will require adherence to the restrictions and requirements set forth in the Site-Specific Addendum to the LUCMRR for the Building 1065 Area.

- LUC Tracking in the Trust's GIS Database – The Trust will include LUC area(s) for the Building 1065 Area in the GIS database that the Trust will use to monitor its LUC sites. This database will be available to Trust staff to facilitate decision making and land use planning for Presidio sites.

- Notification and Annual Monitoring – The Trust will prepare an annual Presidio LUC Report to confirm that land uses within Presidio are consistent with the restrictions and requirements of all LUC areas in Area B of the Presidio. The Trust will provide all stakeholders with a copy of this annual report. In addition, the Trust will notify all stakeholders of any proposed action that may disrupt the effectiveness of the LUCs, and any proposed action that could alter or eliminate the continued need for LUCs.

- Transfer of Ownership or Control – The Trust will notify DTSC and the Water Board of any anticipated transfer of ownership or control of any portion of a LUC area in Area B of the Presidio. In the event of a transfer of ownership or control of the LUC area, in whole or in part, the Trust will record the Presidio's LUCMRR with the City and County of San Francisco Recorder's Office and the Federal General Services Agency (GSA) to place subsequent Presidio owners or managers on notice of the existence of the LUC area. As part of the administrative transfer of the Site, the Trust will notify the subsequent owner or manager of the duty to comply with the LUC and provide a current copy of the LUCMRR.

6.0 PROJECT DOCUMENTATION

This section describes the documents and protocols that will be used during implementation of the corrective actions described in this work plan.

6.1 Daily Field Logs

A Daily Field Log will be developed specific to the project, and will be maintained by the Construction Manager and Engineering Contractor (MACTEC) during remediation (excavation) activities that will document Site activities, any problems that occur, and corrective measures implemented through the day. An example Daily Field Log is included in Appendix C. The Construction Manager and Engineering Contractor will prepare a chronological daily summary report that includes (at a minimum) the following information:

- Date, name of project, and location;
- Weather and Site conditions;
- Onsite personnel and visitors;
- Summary of any meetings conducted and the decisions made during the meetings (separate meeting minutes will be prepared by the Trust);
- Location of daily construction activities, equipment used, and progress made;
- Type, volume, and location (area excavated from and stockpile location) of materials excavated;
- Location of samples collected including excavation areas where the results of soil confirmation samples are above or below cleanup levels;
- Description and quantity of materials received at the Site and the condition in which they were received;
- Description and quantity of materials hauled offsite;
- Identification of construction problems and their solution or disposition; and
- Health and safety considerations.

6.2 Photographic Documentation

Photographs will be taken throughout the corrective action implementation. Photographs will be filed in chronological order and will be labeled and indexed to note date and time, photographer name, location, orientation, and a brief description. Photographs will cover all aspects of the Site work from pre-construction to post. A blank photograph log is included in Appendix C.

6.3 Progress Reports

The Construction Manager and Engineering Contractor will provide weekly construction monitoring progress reports to the Trust. These weekly reports will describe construction work accomplished, work remaining, any schedule variances, and highlight issues that may arise to impede the progress of the project, and will be included as an appendix to the Construction Completion Report described in Section 7.0. More frequent reports will be prepared as necessary to document ongoing data management and decisions made in field.

6.4 Meetings

Tailgate meetings will be held at the Site and be attended by the Construction Manager and Engineering Contractor (MACTEC), the Remediation Contractor (ERRG) and other parties as necessary depending on the work to be completed that day. The daily meetings will focus on health and safety issues or concerns, a review of the work performed the previous day, and the work to be performed during the current day.

Progress meetings will be held weekly, or as needed, at the Trust's office and be attended by the Trust, Remediation Contractor, Construction Manager, Engineering Contractor, and other parties (Water Board, NPS, and DTSC) as necessary. The Construction Manager and Engineering Contractor will keep the Trust informed of the progress of the corrective actions, and the Construction Manager will coordinate all work and contractors, under the oversight of the Engineering Contractor.

The Trust will communicate the status of the project, confirmation sampling results, recommendations for over-excavation and other project issues to the Water Board, NPS and other stakeholders. Additional meetings are anticipated to include kick-off meetings, site walks, and one meeting after construction work is completed after each phase. An agenda will be prepared and faxed out the day before each meeting (except for informal meetings) by the Trust. Meeting minutes will be prepared by the Trust and Construction Manager.

7.0 REPORTING AND DOCUMENTATION

This section identifies the reporting mechanisms and documentation involved with each of the corrective action components that will be implemented at the Site. The Trust's proposed contractors are shown in parentheses:

1. <u>Groundwater Monitoring Well Abandonment, Installation, and Monitoring</u>

- ***Contracting—***Groundwater Monitoring and Well Abandonment/Installation Contractor (T&R);
- ***Planning***—This Work Plan;
- ***Documentation***—Progress reports prepared by the Groundwater Monitoring and Well Abandonment/Installation Contractor for the Trust;
- ***Closure / Follow Up Reporting—***An appendix to the Construction Completion Report will be prepared using data obtained by the Groundwater Monitoring and Well Abandonment/Installation Contractor that summarizes the groundwater monitoring data, that will also be included in the Trust's *Semi-Annual Groundwater Monitoring Report, Presidio-Wide Quarterly Groundwater Monitoring*. The Engineering Contractor (MACTEC) will obtain pre-construction groundwater data from T&R regarding installation, development, and sampling of the new monitoring well, and will evaluate the data in regard to oxygen releasing product application decision-making as described in Section 4.5.7 and Appendix D, Figure D-1. The Engineering Contractor (MACTEC) will prepare the summary of groundwater monitoring data that will be presented in the Construction Completion Report, which will include an evaluation of the groundwater monitoring results. If post-excavation data indicates petroleum-related COC concentrations in groundwater are below cleanup levels, the report will document that ongoing monitoring will be performed as described in the CAP. If post-excavation data indicates petroleum-related COCs in groundwater are above cleanup levels, the report will include an assessment of the need for and/or recommendations regarding application of oxygen releasing product, as well as a description of any associated follow-up reporting that is determined to be necessary.

2. <u>Excavation and Offsite Disposal, and Application of Oxygen Releasing Product as Necessary at Building 1063</u>

- ***Contracting***—Remediation Contractor procured by the Trust (ERRG);
- ***Planning and Procurement***—This Work Plan and Construction Documents (*MACTEC, 2007b*);
- ***Documentation—***Progress reports prepared by the Construction Manager and Engineering Contractor (MACTEC) for the Trust;
- ***Closure / Follow Up Reporting***—Construction Completion Report prepared by the Construction Manager and Engineering Contractor (MACTEC).

3. <u>Indoor Cap Inspection and Air/Soil Vapor Sampling at Building 1040</u>

- ***Contracting***—Building 1040 Indoor Cap Corrective Action Contractor (EKI);

- ***Planning***—Work Plan Addendum prepared by the Building 1040 Indoor Cap Corrective Action Contractor (EKI);
- ***Documentation***—Progress reports prepared by the Building 1040 Indoor Cap Corrective Action Contractor (EKI) for the Trust;
- ***Closure / Follow Up Reporting***—An appendix to the Construction Completion Report prepared by the Building 1040 Indoor Cap Corrective Action Contractor that documents the results of the work described in the Work Plan Addendum, including all progress reports, implementation reporting communications, data, and records.

4. <u>Outdoor Cap Inspection at Building 1040</u>

- ***Contracting***—Building 1040 Outdoor Cap Inspection Contractor (MACTEC);
- ***Planning***—This Work Plan;
- ***Documentation***— Progress reports prepared by the Construction Manager and Building 1040 Outdoor Cap Inspection Contractor (MACTEC) for the Trust;
- ***Closure / Follow Up Reporting—***Construction Completion Report prepared by the Building 1040 Outdoor Cap Inspection Contractor that documents the results of the work, including all progress reports, implementation reporting communications, data, and records.

5. <u>Land Use Controls</u>

- ***Contracting***—Land Use Controls Contractor (MACTEC);
- ***Planning***—This Work Plan;
- ***Closure / Follow Up Reporting*** —An addendum to the LUCMRR prepared by the Land Use Controls Contractor (MACTEC); a copy will be included as an addendum to the Construction Completion Report. A temporary LUC will be implemented for RUs-A where source removal will be performed. It is anticipated that after petroleum-related COCs TPHg, BTEX, and arsenic are demonstrated to be below cleanup levels for four consecutive sampling rounds in groundwater monitoring wells and the newly installed well, monitoring will be discontinued (subject to Water Board approval), the LUC at RUs-A will be removed, and clean closure with regards to groundwater contamination will be documented in a Site closure report and a site-specific addenda to the LUCMRR. At RU-C, the LUC will be permanently documented in the site-specific addenda to the LUCMRR.

6. <u>Five-Year Status Report for RUs-A and RU-C</u>

- ***Five-Year Status Report***—Five-Year Status Report will be completed and submitted to the Water Board that summarizes the status of the corrective action at RUs-A and RU-C. It is anticipated that the first report will be submitted in 2012.

Upon completion of the corrective action described in this Work Plan, the Engineering Contractor will prepare a Construction Completion Report. The Construction Completion report will present an overall project summary and findings, and will include the following items:

- Brief introduction and Site history;
- Well abandonment and installation and related survey data (boring logs and monitoring well completion logs for the monitoring well 1065MW103A);
- Groundwater monitoring data collected for the project duration (at a minimum, analytical results from the first round of groundwater monitoring from the newly installed groundwater well and existing wells identified in Table 2-1);
- Material removal procedures including excavation, material segregation, stockpiling, and backfilling;
- Description of observations of excavated materials;
- Oxygen releasing product application, if necessary;
- Equipment utilization;
- Cap inspection and indoor soil vapor and air sampling results;
- Site restoration activities;
- Sampling and laboratory methods and QA/QC procedures;
- Presentation of the results and Chain of Custody forms for the analytical sampling and analysis of soil and other waste material;
- Permits and Inspection Reports;
- Survey reports and maps showing pre-construction, excavation record, intermediate backfill (if needed), and final record areas and elevations;
- Drawing(s) showing sample locations;
- Transportation records including bills of lading and hazardous waste manifests;
- Certifications of disposal from disposal facilities;
- Analytical reports of fill materials used to backfill the excavation and location of borrow source;
- Photographs of work showing the sequence of work;
- A description of proposed LUCs for RUs-A and RU-C (the Site-specific LUCMRR addendum will be submitted as an addendum to the Construction Completion Report);
- QA/QC results for the corrective action implementation; and
- Chemical analyses and reporting (laboratory reports) that comply with the Presidio-Wide QAPP with Level III/IV data validation, data validation reports, and electronic data deliverables (EDDs) that comply with Trust's current format.

8.0 SCHEDULE

The Remediation Contractor (ERRG) will sequence excavation activities in a manner that will ensure that the corrective action is implemented in an orderly, efficient, and safe manner and in accordance with the Construction Documents (*MACTEC, 2007b*). The planned work sequence for major construction milestones are presented on Plates 8-1a and 8-1b. Some items are tentative and may be modified based on the findings of earlier operations, agency/permitting delays, or contingency operations.

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TABLES

Table 1-1. Cleanup Levels for Soil

Chemica1 [(a)]	Cleanup Level [(c)] (mg/kg)	(b)
Total Petroleum Hydrocarbons (TPH)		
TPH (as gasoline)	100	2
TPH (as diesel)	115	2
TPH (as fuel oil)	160	2
PAHs		
Acenaphthene	2,700	1
Acenaphthylene	--	--
Anthracene	308	2
Benzo(a)anthracene	0.43	2
Benzo(a)pyrene	0.04	2
Benzo(b)fluoranthene	0.43	2
Benzo(g,h,i)perylene	620	2
Benzo(k)fluoranthene	0.43	2
Chrysene	4.3	2
Dibenzo(a,h)anthracene	0.078	1
Fluoranthrene	316	2
Fluorene	60	2
Indeno(1,2,3-c,d)pyrene	0.27	1
Naphthalene	9	2
Phenanthrene	86	2
Pyrene	241	2
VOCs		
Acetone	0.24	1
Benzene	0.005	2
Bromodichloromethane	0.014	3
Bromoform	2.2	3
Bromomethane	0.22	3
2-Hexanone (MIBK)	2.8	4
Carbon disulfide	200	1
Carbon tetrachloride	0.012	3
Chlorobenzene	1.5	3
Chloroethane	0.63	3
2-Chloroethyl vinyl ether	--	--
Chloroform	0.098	3
Chloromethane	0.29	3

Table 1-1. Cleanup Levels for Soil

Chemical1 [a]	Cleanup Level [c] (mg/kg)	(b)
Dibromochloromethane	0.019	3
1-1-Dichloroethane	0.2	3
1,2-Dichloroethane	0.0045	3
cis-1,2-Dichloroethene	0.19	3
trans-1,2-Dichloroethene	0.67	3
1,2-Dichloropropane	0.052	3
cis-1,3-dichloropropene	0.033	3
trans-1,3-dichloropropene	0.033	3
Ethylbenzene	0.005	5
2-Butanone (MEK)	3.9	1
Methylene chloride	0.076	1
Methyl-tert butyl ether	0.023	3
4-Methyl-2-pentanone (MIBK)	2.7	3
Styrene	1.5	3
1,1,2,2-Tetrachloroethane	0.0091	3
Tetrachloroethene	0.087	3
Toluene	0.005	5
1,1,1-Trichloroethane	8	1
1,1,2-Trichloroethane	0.032	3
Trichloroethene	0.26	3
Vinyl acetate	430	3
Vinyl chloride	0.0067	3
Total Xylenes	0.005	5
Metals		
Aluminum	76,000	6
Antimony	29	1
Arsenic	5.9	1
Barium	5,000	1
Beryllium	140	1
Cadmium	1.7	1
Calcium	--	--
Chromium	1,200	1
Cobalt	4,000	1
Copper	230	3
Iron	--	--
Lead	400	1
Magnesium	--	--
Manganese	1,800	6
Mercury	20	1
Molybdenum	360	1

Table 1-1. Cleanup Levels for Soil

Chemical [a]	Cleanup Level [c] (mg/kg)	(b)
Nickel	1,400	1
Potassium	--	--
Selenium	360	1
Silver	360	1
Sodium	--	--
Thallium	5.7	1
Vanadium	650	1
Zinc	22,000	1

mg/kg = Milligram per kilogram
RWQCB ESL = Regional Water Quality Control Board Environmental Screening Levels
PRG = Preliminary Remediation Goal

(a) Only chemicals that were identified as COCs and/or were included in the confirmation sampling program Area are listed.

(b) Cleanup levels selected from the following:

1 = Presidio-wide Cleanup Level Document (PWCLD; *EKI, 2002*), Tables 7-2.

2 = Presidio-wide Cleanup Level Document (PWCLD; *EKI, 2002*), Table 7-5.

3 = RWQCB soil ESL (lowest of human toxicity and indoor air impacts) (*RWQCB, 2003*).

4 = RWQCB soil cleanup level (lowest of human toxicity and indoor air impacts) (RWQCB, 2003). Surrogate cleanup level for 2-hexanone is ESL for methyl isobutyl ketone (MIBK).

5 = Cleanup level for these constituents from the California Regional Water Quallity Control Baord, San Francisco Bay Region, Order No. R2-2003-0080.

6 = Soil PRG (*USEPA, 2004*).

(c) Residential land use cleanup levels were selected, unless for metals, the background level was higher, then the background level was selected as the applicable cleanup level.

-- For chemicals with no cleanup levels, there are no Presidio cleanup levels, RWQCB ESLs, or USEPA PRGs.

Checked SG

Approved SLK

Table 1-2. Cleanup Levels for Groundwater

Chemical [a]	Cleanup Level (µg/L)	Source of Cleanup Level [b]
Total Petroleum Hydrocarbons (TPH)		
TPH as gasoline	770	Presidio-Wide Cleanup Level Document/TPH POC Concentrations
Metals / Inorganics		
Antimony	6	Presidio-Wide Cleanup Level Document
Arsenic	10	Presidio-Wide Cleanup Level Document
Volatile Organic Compounds (VOCs)		
Benzene	1	Presidio-Wide Cleanup Level Document
Ethylbenzene	300	California MCL
Toluene	150	Presidio-Wide Cleanup Level Document
Xylenes	1,750	California MCL/Presidio-Wide Cleanup Level Document

µg/L Micrograms per liter.
MCL Maximum contaminant level.
-- Not available - where no level is listed, there are no Presidio cleanup levels or federal or California MCLs for the compound.

[a] Only identified groundwater COCs or PCOCs are listed.

[b] Presidio-wide Cleanup Level Document (PWCLD; *EKI, 2002*), Table 7-6.
Development of Freshwater TPH-diesel and TPH-fuel oil Point of Compliance Concentrations (BBL, 2004)
Federal and California MCL on http://www.dhs.ca.gov/ps/ddwem/chemicals/MCL/EPAandDHS.pdf
RWQCB Basin Plan (*RWQCB, 2004*)

Checked SG

Approved SUK

Table 2-1. Groundwater Monitoring Program

<table>
<tr><th>Well ID</th><th>Water Bearing Zone</th><th>Objectives</th><th>Analytes (1)</th><th>Monitoring Frequency</th><th>Monitoring Duration</th></tr>
<tr><td colspan="6">RU-A Monitoring Wells</td></tr>
<tr><td>1065MW103A (replaces 1065PZ1A)</td><td>Shallow Zone</td><td rowspan="3">Monitor in the vicinity of RU-A for petroleum-related COCs

Monitor for Arsenic & Redox Parameters, arsenic, aluminum, iron, manganese, field parameters

Monitor groundwater levels</td><td rowspan="3">TPHg/BTEX

Arsenic & Redox parameters, aluminum, iron, manganese, field parameters</td><td rowspan="3">TPHg/BTEX: Quarterly for 1 year, then semi-annually

Arsenic & Redox Parameters, aluminum, iron, manganese, field parameters: Quarterly for 1 year, then annually

Groundwater Level Monitoring: Each monitoring event</td><td rowspan="3">TPHg/BTEX: Until four consecutive rounds of TPHg & BTEX concentrations below cleanup levels

Arsenic & Redox Parameters, aluminum, iron, manganese, field parameters: Until concentrations of arsenic below cleanup levels

Groundwater Level Monitoring: Until site-wide groundwater monitoring program ends</td></tr>
<tr><td>1065MW101A</td><td>Shallow Zone</td></tr>
<tr><td>1065MW102A</td><td>Shallow Zone</td></tr>
<tr><td colspan="6">Wells Monitored for Arsenic & Redox Parameters, Aluminum, Iron, Manganese, Field Parameters Only</td></tr>
<tr><td>1065PZ2A</td><td>Shallow Zone</td><td rowspan="6">Monitor for Redox parameters, arsenic, aluminum, iron, manganese, field parameters

Monitor groundwater levels</td><td rowspan="6">Arsenic & Redox parameters, aluminum, iron, manganese, field parameters</td><td rowspan="6">Arsenic & Redox Parameters, aluminum, iron, manganese, field parameters: Quarterly for 1 year, then annually

Groundwater Level Monitoring: Each monitoring event</td><td rowspan="6">Arsenic & Redox Parameters, aluminum, iron, manganese: Until concentrations of arsenic below cleanup levels

Groundwater Level Monitoring: Until site-wide groundwater monitoring program ends</td></tr>
<tr><td>1065PZ3A</td><td>Shallow Zone</td></tr>
<tr><td>1065PZ4A</td><td>Shallow Zone</td></tr>
<tr><td>1065PZ5AR</td><td>Shallow Zone</td></tr>
<tr><td>1065PZ6A</td><td>Shallow Zone</td></tr>
<tr><td>1065MW10A</td><td>Shallow Zone</td></tr>
<tr><td colspan="6">Wells Used for Groundwater Level Monitoring Only</td></tr>
<tr><td>1027MW01</td><td>Shallow Zone</td><td rowspan="14">Monitor groundwater levels</td><td rowspan="14">Not applicable</td><td rowspan="14">Quarterly for 1 year (TPHg/BTEX / Arsenic & Redox Parameter monitoring frequency)

Then semi-annually (TPHg/BTEX monitoring frequency until concentrations below cleanup levels)

Then annually (Arsenic & Redox Parameters monitoring frequency until arsenic concentrations below cleanup levels)</td><td rowspan="14">Until site-wide groundwater monitoring program ends</td></tr>
<tr><td>1027MW01</td><td>Shallow Zone</td></tr>
<tr><td>1027MW03</td><td>Shallow Zone</td></tr>
<tr><td>1065PZ7A</td><td>Shallow Zone</td></tr>
<tr><td>1065MW11A</td><td>Shallow Zone</td></tr>
<tr><td>1047MW101A</td><td>Shallow Zone</td></tr>
<tr><td>1065PZ2B</td><td>Intermediate Zone</td></tr>
<tr><td>1065PZ3B</td><td>Intermediate Zone</td></tr>
<tr><td>1065PZ4B</td><td>Intermediate Zone</td></tr>
<tr><td>1065PZ5B</td><td>Intermediate Zone</td></tr>
<tr><td>1065PZ6B</td><td>Intermediate Zone</td></tr>
<tr><td>1065PZ7B</td><td>Intermediate Zone</td></tr>
<tr><td>1065MW10B</td><td>Intermediate Zone</td></tr>
<tr><td>1065MW11B</td><td>Intermediate Zone</td></tr>
</table>

Notes

All wells will be abandoned at the end of the site-wide groundwater monitoring program and after site closure.

(1) TPHg analyzed by EPA Test Method 8015 modified / BTEX analyzed by EPA Test Method 8021B; arsenic, aluminum, iron, manganese analyzed by EPA Test Method 6010.

"Redox parameters" are other metals analyzed under EPA Test Method 6010 and field measurement of dissolved oxygen (DO) and oxidation-reduction potential (ORP). "Field Parameters" include water level measurements, pH, temperature, electrical conductance (EC).

1065PZ1A, 1065PZ1B, 1065MW9A, 1065MW9B, will be abandoned prior to excavation. 1065PZ1B, 1065MW9A, and 1065MW9B will not be replaced. A replacement well for 1065PZ1A will be installed prior to excavation at RU-A.

Checked

Approved

Table 3-1. Project Team Responsibilities

Project Team Member	Responsibilities		
	Pre-Construction	**During Construction**	**Post-Construction**
Owner (Presidio Trust)	Review Work Plan.	Review and sign all manifests.	Submit Construction Completion Report to regulatory agencies.
	Review Contractor Submittals.	Coordinate traffic with all tenants, residents, and visitors.	
	Attend Site walk with Remediation Contractor and Engineering Contractor.	Coordinate monitoring and documentation by cultural and natural resources professionals.	
	Notify USA and mark all utilities.	Construction manager; coordinate with all contractors and team members.	
Construction Manager (MACTEC)		Leading and facilitating all construction meetings, preparing minutes of the meetings, and distributing minutes to all attending and involved parties. Reviewing the Contractor progress and construction schedule to identify and discuss any potential impacts or delays. In cooperation with the Trust's Project Manager and Contracting Officer, the CM will enforce requirements of the construction contract with the Contractor.	
Engineering, Construction Quality Assurance, Building 1040 Outdoor Cap Inspection, and Land Use Control Contractor (MACTEC)	Prepare this Work Plan for remedial activities (including Construction Drawings and Technical Specifications).	Observe Work in progress. Provide construction monitoring during construction activities. Attend pre construction, weekly, and construction problem or deficiency meetings.	Prepare Construction Completion Report.
	Prepare a Health and Safety Plan (HASP).	Provide design clarifications and revisions as needed.	Prepare Closure Report.
	Attend a Site walk with Remediation Contractor and Trust.	Collect confirmation samples and submit to laboratory.	Prepare LUCMRR Addendum
	Prepare field notes and documentation, including modifications to the proposed field activities.	Prepare field meeting notes and adequate documentation of field activities. Prepare schedule of CQA monitoring activities.	
	Assist Trust with construction management/administration activities.	Provide instruction to the Engineering Contractor in CQA requirements and procedures pertaining to earthwork excavation, monitoring, and confirmation sampling.	
	Prepare and submit a sampling and analysis plan to the Trust.	Review and interpret data and reports prepared by Engineering Contractor. Identify work that will be accepted or rejected based on monitoring observations or test results. Assist Trust with construction management/administration activities.	
	Inspect outdoor cap adjacent to Building 1040 foundation	Sample and analyze waste water for disposal or discharge to the Presidio Sanitary Sewer.	
	Attend Site walk with Trust and Engineer.	Submit laboratory analytical results to the Trust.	
	Conduct outdoor cap inspection at Building 1040.	Prepare periodic acceptance reports and the Construction Quality Assurance Report.	

Table 3-1. Project Team Responsibilities

Project Team Member	Responsibilities: Pre-Construction	Responsibilities: During Construction	Responsibilities: Post-Construction
Remediation Contractor (ERRG)	Prepare construction submittals for the Trust; including: 1) Environmental Protection Plan (includes erosion and sediment control plan, spill control plan, non-hazardous solid waste disposal plan, air pollution control plan, contaminant prevention plan, waste water management plan, and truck cleaning plan). 2) HAZWOPER qualification certificates. 3) Health and Safety Plan (HASP) 4) Site Plan (proposed location and dimensions of any areas to be fenced and used by Contractor 5) Dewatering Plan.	As described in the technical specifications including, but not limited to:	As described in the technical specifications including, but not limited to:
		Prepare working as-built drawings for Trust review.	Prepare and submit close-out submittals, including final as-built drawings.
		Accommodate confirmation sampling performed by Engineer.	
		Contractor's Project Manager will be responsible to the Trust for ensuring that contractual obligations are fulfilled, and that deliverables meet program-specific consistency and quality objectives. The Contractor's Project Manager will be responsible for all day-to-day communications and operations with the Trust and will: 1) Oversee the project activities to assure that adequate resources are maintained 2) Verify that contractual budget and schedule requirements are being met	
	Submit survey information and drawings to Trust.	3) Verify that the accompanying Construction Documents are properly implemented.	
	Provide Demolition Methods and Construction Procedures Plans to Trust.	Protect the public, cultural and natural resources.	
	Prepare Excavation and Handling Methods Plan: Submittal to Trust.	Provide Trust with manifests and backup documents 5 days prior to disposal.	
	Submit disposal sites information and waste profiling form: Submittal to Trust.	Perform all waste profile sampling and submit test reports to Trust and Engineer.	
	Provide a construction schedule to the Engineer and the Trust.	Provide Trust with waybills and shipping documents.	
	Provide a Traffic Control Plan to the Trust.	Identify potential import soils.Test/classify soil, aggregate base, and bituminous pavement to determine physical properties.	
	Provide the field superintendent contact information to the Trust and Engineer.	Work with Trust to identify potential import soils.	
		Provide visible field control to Engineer and survey extent of all excavations.	
		Provide Trust with inspection test reports for concrete formwork.	
		Provide Trust with the amount of oxygen release product used, number of product containers and volumes, and product invoices.	
		Submit excavation as-built drawings to the Trust.	

Table 3-1. Project Team Responsibilities

Project Team Member	Responsibilities		
	Pre-Construction	During Construction	Post-Construction
Remediation Contractor (ERRG) --- cont'd		Contractor's Site Superintendent has the responsibility of seeing that the work progresses on schedule and in accordance with the Work Plan, and will: 1) Coordinate the work of the Contractor's in-house and subcontract staff. 2) Attend meetings. 3) Interface with the Trust and Engineer. 4) Diligently monitor schedule and field operations. 5) Document information and maintain files.	
Groundwater Monitoring Contractor (T&R)	Collect depth to water, field redox parameters, and groundwater samples for analysis on a quarterly basis	Collect depth to water, field redox parameters, and groundwater samples for analysis on a quarterly basis	Collect depth to water, field redox parameters, and groundwater samples for analysis on a quarterly basis
	Arrange sub-contracted drilling company to destroy 1065PZ1A, 1065PZ1B, 1065MW9A, and 1065MW9B and install one replacement well		Document in Semi-Annual Groundwater Monitoring Report and Construction Completion report
	Survey new monitoring well location and elevation		Document in Semi-Annual Groundwater Monitoring Report and Construction Completion report
Building 1040 Indoor Cap Corrective Action Contractor (EKI)	Prepare appendix to work plan to conduct indoor inspection and identify any needed capping improvements, assessment of vapor phase intrusion via sampling.	Conduct inspection and sampling, implement any improvements	Document in Construction Completion report
NPS	Review and approve Work Plan.	Review amendments to Work Plan; confer on excavation boundaries, confirmation sample results, Building 1040 inspection and indoor air sample results.	Review Construction Completion Report. Review Closure Report.
Water Board	Review and approve Work Plan.	Review amendments to Work Plan; confer on excavation boundaries, confirmation sample results, Building 1040 inspection and indoor air sample results.	Review and approve Construction Completion Report. Review and approve Closure Report.
DTSC	Review Work Plan.		
RAB	Review Work Plan.		

Checked SG   Approved SCK

Table 3-2. Project Team Points of Contact

Agency	Name and Title	Address	Phone Number
Presidio Trust (Owner)	Ryan Seelbach Project Manager Craig Cooper Remediation Program Manager	Presidio Trust P.O. Box 29052 San Francisco, CA 94129-0052 (Building 67)	(415) 561-5082 (Office) RSeelbach@presidiotrust.gov (415) 561-4259 (Office) CCooper@presidiotrust.gov
Engineering, Construction Manager, Construction Quality Assurance, Outdoor Cap Inspection, Land Use Control Contractor (MACTEC)	James P. Henderson, P.E. Design Task Manager	4704 Roseville Road, Suite 108 North Highlands, CA 95660	(916) 332-5552
Remediation Contractor (ERRG)	Rowan Tucker, Principal-in-Charge Tyson Appel, REA, Project Manager/ Site Supervisor David Tang, P.E., G.E., Project Engineer	251 Kearny Street, Suite 502 San Francisco, CA 94108	(415) 395-9974
Goundwater Monitoring Contractor (T&R)	Joshua Graber Senior Project Manager	555 Montgomery Street, Suite 1300 San Francisco, CA 94111	(415) 955-9040 jdgraber@treadwellrollo.com
Indoor Inspection/Sampling Contractor (EKI)	Michelle King	1870 Ogden Drive Burlingame, CA 94010	(650) 292-9100
National Park Service (NPS)	Brian Ullensvang, P.E. Environmental Engineer	Golden Gate National Recreation Area Fort Mason, Building 201 San Francisco, CA 94123	(415) 561-4726 Brian_Ullensvang@nps.gov
California Water Quality Control Board (Water Board), San Francisco Bay Region (Lead Agency)	Devender Narala, P.E.	1515 Clay Street, Suite 1400 Oakland, CA 94612	(510) 622-2309 dnarala@waterboards.ca.gov
California Department of Toxic Substances Control (DTSC)	Robert Boggs, P.E.	700 Heinz Avenue, Suite 200 Berkeley, CA 94710-2737	(510) 540-3751 RBOGGS@dtsc.ca.gov
Presidio Trust Utilities Department	Robert Malaca Utilities Manager	Building 1750 Presidio Trust P.O. Box 29052 San Francisco, CA 94129-0052	(415) 561-3924 rmalaca@presidiotrust.gov
Presidio Trust and NPS Archeology Contacts	Sannie Osborn Historic Archeologist Leo Barker	Presidio Trust P.O. Box 29052 San Francisco, CA 94129-0052	(415) 561-5090 sosborn@presidiotrust.gov (415) 561-4832 leo_barker@nps.gov

Checked SG Approved SM

Table 4-1. Wastewater Discharge Limits

Test Method	Analyte Name	Discharge Limit [(a)]
150.1	pH	6.0-9.5
	Temperature	125°F
6010	Arsenic	4.0 mg/L
	Cadmium	0.5 mg/L
	Chromium	5.0 mg/L
	Copper	4.0 mg/L
	Lead	1.5 mg/L
	Nickel	2.0 mg/L
	Silver	0.6 mg/L
	Zinc	7.0 mg/L
7470	Mercury	0.05 mg/L
418.1	TPH Total Recoverable Petroleum Hydrocarbons	300
4131	TPH Oil and Grease	100
8260	Acetone	N/A
	Benzene	500
	Chloroform	6,000
	Ethylbenzene	N/A
	Tetrachloroethene	7,000
	Toluene	N/A
	Xylenes (m&p-)	N/A
335.2	Cyanide	1.0 mg/L
420.1	Phenols	23.0 mg/L
9060[(b)]	Dissolved Sulfides	0.5 mg/L

mg/L = milligrams per liter.

N/A = not applicable, no discharge limit for this analyte.

(a) = Numerical values from San Francisco Public Utilities Commision Industrial User Class II Wastewater Permit No. 05-0246 for the Presidio of San Francisco.

(b) Analytical method specified in Wastewater Permit No. 05-0246 is for total organic carbon; dissolved sulfide will be analyzed using test method 376.2.

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PLATES

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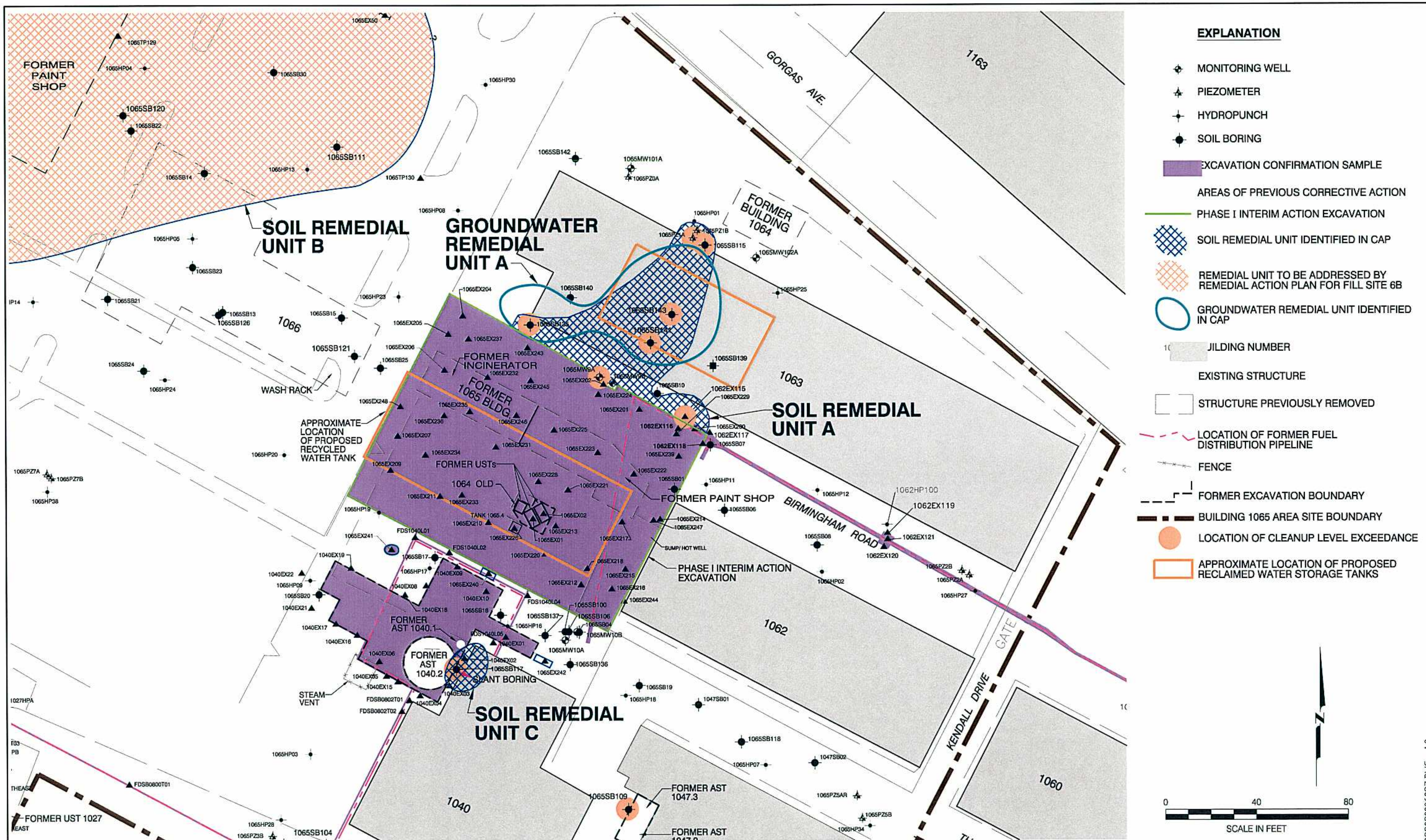
PLATE

MACTEC

Site Location Map
Corrective Action Implementation Work Plan
Building 1065 Area
Presidio of San Francisco, California

1-1

DRAWN	JOB NUMBER	CHECKED	CHECKED DATE	APPROVED	APPROVED DATE
CN	4089030006 00311	[illegible]	04/07	SW	5/07



PLATE

MACTEC

Site Plan and Remedial Units
Corrective Action Implementation Work Plan
Building 1065 Area
Presidio of San Francisco, California

1-2

DRAWN	JOB NUMBER	CHECKED	CHECKED DATE	APPROVED	APPROVED DATE
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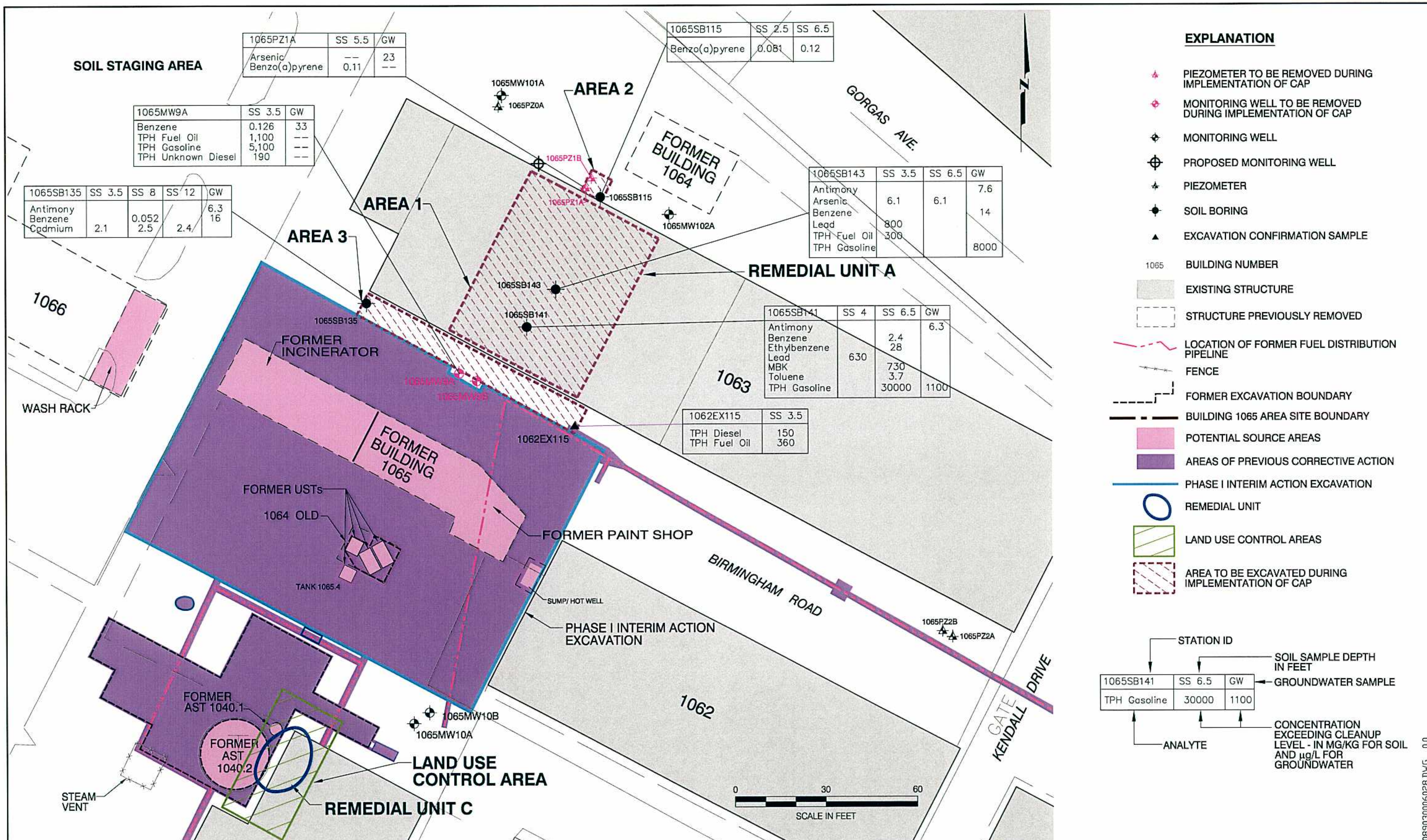
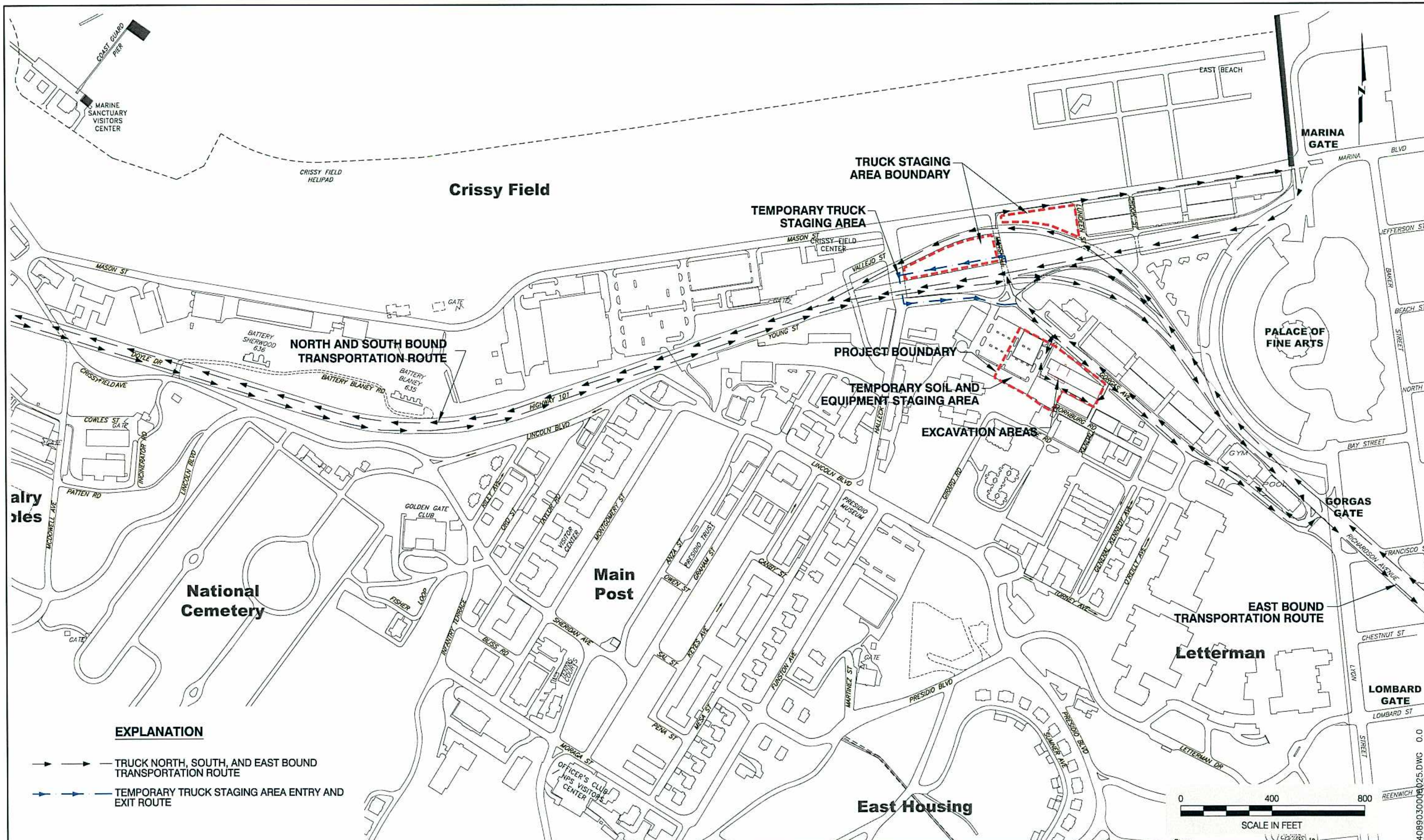


MACTEC

Concentrations Exceeding Cleanup Level in Soil and Groundwater
Corrective Action Implementation Work Plan
Building 1065 Area
Presidio of San Francisco, California

PLATE **1-3**

DRAWN	JOB NUMBER	CHECKED	CHECKED DATE	APPROVED	APPROVED DATE
CN	4089030006 00311		05/07	SM	5/07



NOTES:

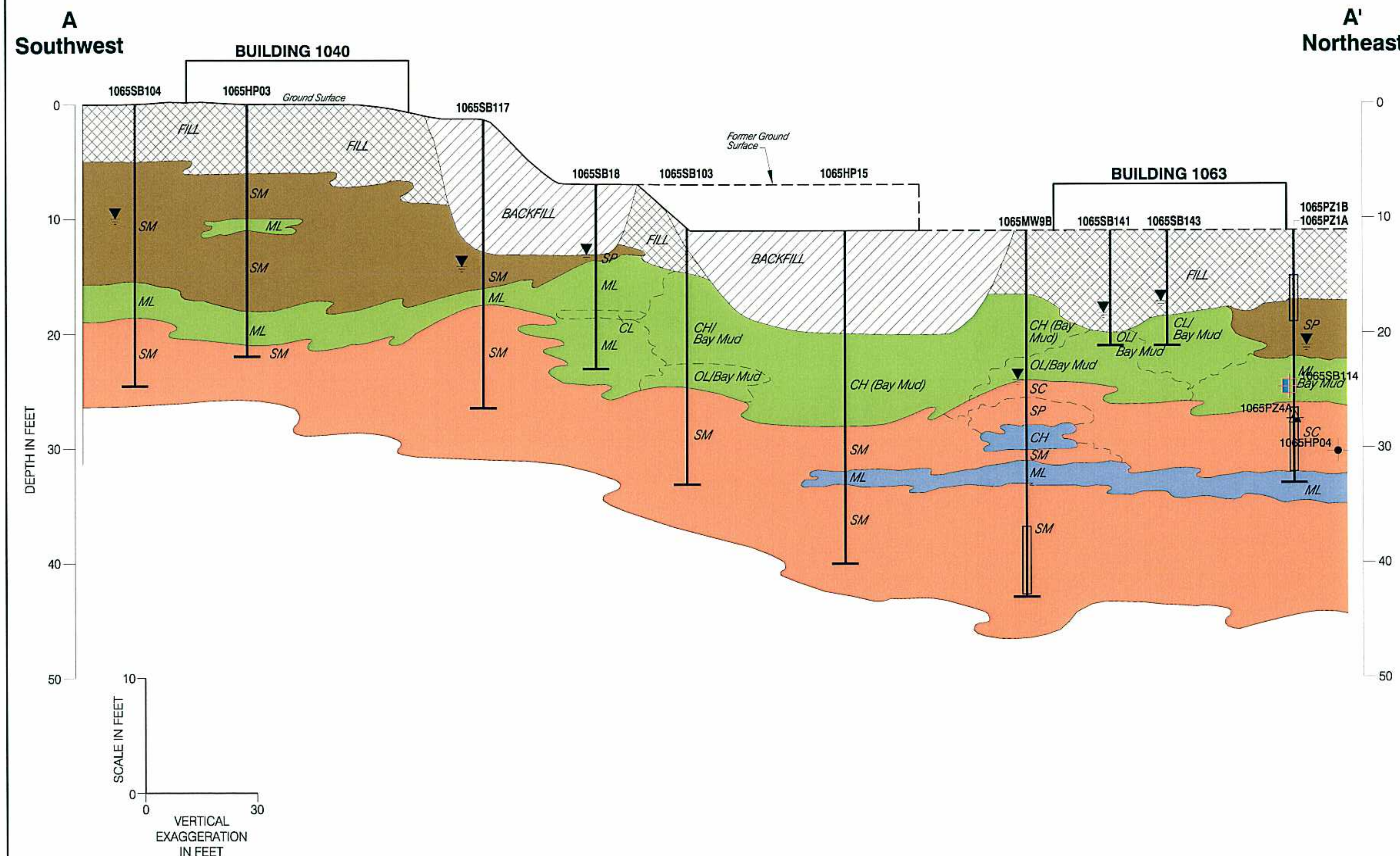
1. NO DEVIATIONS FROM APPROVED ROUTES WITHOUT WRITTEN PERMISSION OF PRESIDIO TRUST.
2. TRUCK STAGING AREA WILL BE IDENTIFIED BY TRUST PRIOR TO COMMENCEMENT OF WORK, NO MORE THAN THREE (3) TRUCKS SHALL BE ALLOWED IN THE PROJECT BOUNDARY AT ONE TIME.
3. CONTRACTOR SHALL ERECT OR MAINTAIN EXISTING TEMPORARY FENCING ALONG PROJECT BOUNDARY.

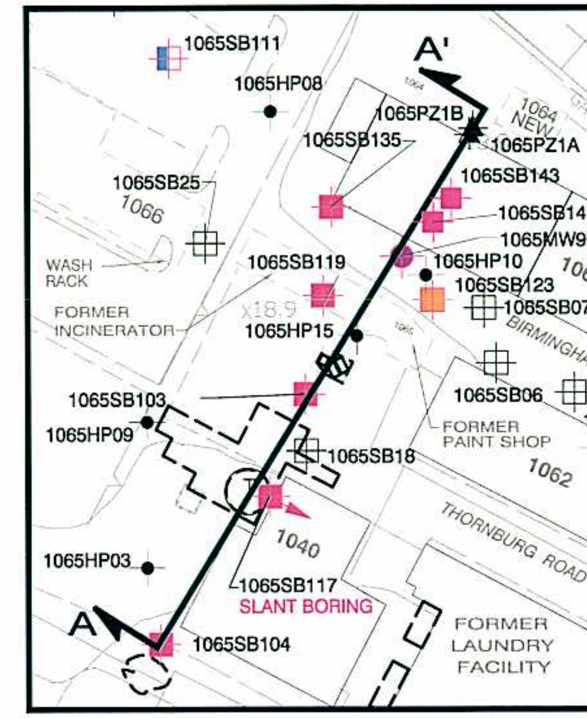
MACTEC

Transportation Plan
Corrective Action Implementation Work Plan
Building 1065 Area
Presidio of San Francisco, California

PLATE **4-1**

DRAWN	JOB NUMBER	CHECKED	CHECKED DATE	APPROVED	APPROVED DATE
CN	4089030006 00311		04/07		5/07





CROSS-SECTION LOCATION MAP

EXPLANATION

- SOIL BORING
- HYDROPUNCH
- PIEZOMETER
- MACTEC 25-FOOT SOIL BORING - SOIL AND GROUNDWATER SAMPLES
- SLANT BORING
- MACTEC 40-FOOT SOIL BORING - SOIL AND GROUNDWATER SAMPLES
- MACTEC 10-FOOT SOIL BORING - SOIL SAMPLES ONLY

NOTE: Cross section taken from April 2006 Corrective Action Plan.

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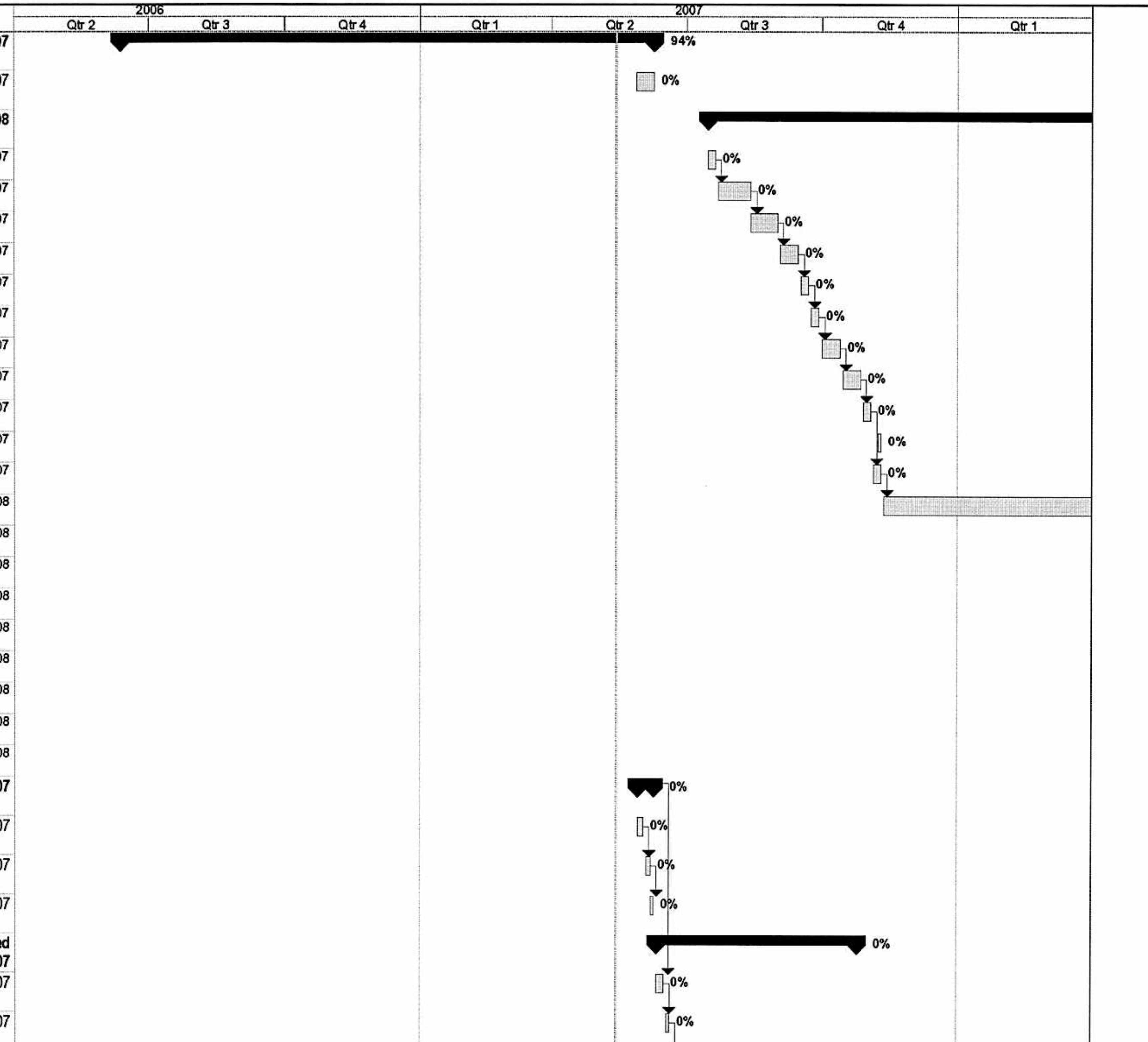
MACTEC

Geologic Cross-Section A-A'
Corrective Action Implementation Work Plan
Building 1065 Area
Presidio of San Francisco, California

PLATE **4-2**

DRAWN	JOB NUMBER	CHECKED	CHECKED DATE	APPROVED	APPROVED DATE
CN	4089030006 00311		04/07	SVR	5/07

ID	Unique ID	Task Name	Duration	Planned Start	Planned Finish
1	**15**	**Work Plan for Bldg 1065**	**260 days**	**Mon 6/12/06**	**Fri 6/8/07**
13	117	Receive agency approval of Final Draft Work Plan for B1065	10 days	Mon 5/28/07	Fri 6/8/07
14	**224**	**Building 1040 Foundation Inspection and Indoor Air Monitoring**	**261 days**	**Mon 7/16/07**	**Mon 7/14/08**
15	231	Prepare draft final Work Plan for Building 1040	5 days	Mon 7/16/07	Fri 7/20/07
16	232	Collect samples	16 days	Mon 7/23/07	Mon 8/13/07
17	233	Obtain Sampling Results	14 days	Tue 8/14/07	Fri 8/31/07
18	234	Post sampling results on figures, calculate RBTCs, and evaluate results with Trust and NPS	10 days	Mon 9/3/07	Fri 9/14/07
19	235	Discuss sampling results and figure with Integrated Team	5 days	Mon 9/17/07	Fri 9/21/07
20	236	Finalize indoor air sampling approach based on soil gas/subslab data	5 days	Mon 9/24/07	Fri 9/28/07
21	237	Conduct 1st round of Indoor Air Monitoring	10 days	Mon 10/1/07	Fri 10/12/07
22	238	Obtain Sampling Results	10 days	Mon 10/15/07	Fri 10/26/07
23	239	Evaluate results and discuss with Trust and NPS	5 days	Mon 10/29/07	Fri 11/2/07
24	250	Building 1040 external Cap inspection and maintenance	2 days	Thu 11/8/07	Fri 11/9/07
25	240	Discuss results with Integrated Team	5 days	Mon 11/5/07	Fri 11/9/07
26	241	Conduct 2nd Round of Indoor Air Monitoring	104 days	Mon 11/12/07	Thu 4/3/08
27	242	Obtain Sampling Results	11 days	Fri 4/4/08	Fri 4/18/08
28	243	Evaluate results and discuss with Trust and NPS	5 days	Mon 4/21/08	Fri 4/25/08
29	244	Discuss results with Integrated Team	5 days	Mon 4/28/08	Fri 5/2/08
30	245	Submit Draft Indoor Air Completion Report	10 days	Mon 5/5/08	Fri 5/16/08
31	246	Receipt of comments on Draft Indoor Air Completion Report	15 days	Mon 5/19/08	Fri 6/6/08
32	247	Submit revised Draft Indoor Air Completion Report	5 days	Mon 6/9/08	Fri 6/13/08
33	248	Receipt of stakeholder comments on Draft Indoor Air Completion Report	16 days	Mon 6/16/08	Mon 7/7/08
34	249	Finalize Indoor Air Completion Report	5 days	Tue 7/8/08	Mon 7/14/08
35	**147**	**Pre-construction Site Work**	**9 days**	**Tue 5/29/07**	**Fri 6/8/07**
36	148	Destroy Monitoring Wells at B1065	4 days	Tue 5/29/07	Fri 6/1/07
37	156	Install Replacement Monitoring Well	3 days	Mon 6/4/07	Wed 6/6/07
38	157	Survey Well Locations	2 days	Thu 6/7/07	Fri 6/8/07
39	**96**	**Site Work at Bldg 1065**	**98 days**	**Mon 6/11/07**	**Wed 10/24/07**
40	97	Mobilization / Preconstruction Survey at B1065	1 wk	Mon 6/11/07	Fri 6/15/07
41	98	Utility Abandonment at B1065	2 days	Mon 6/18/07	Tue 6/19/07

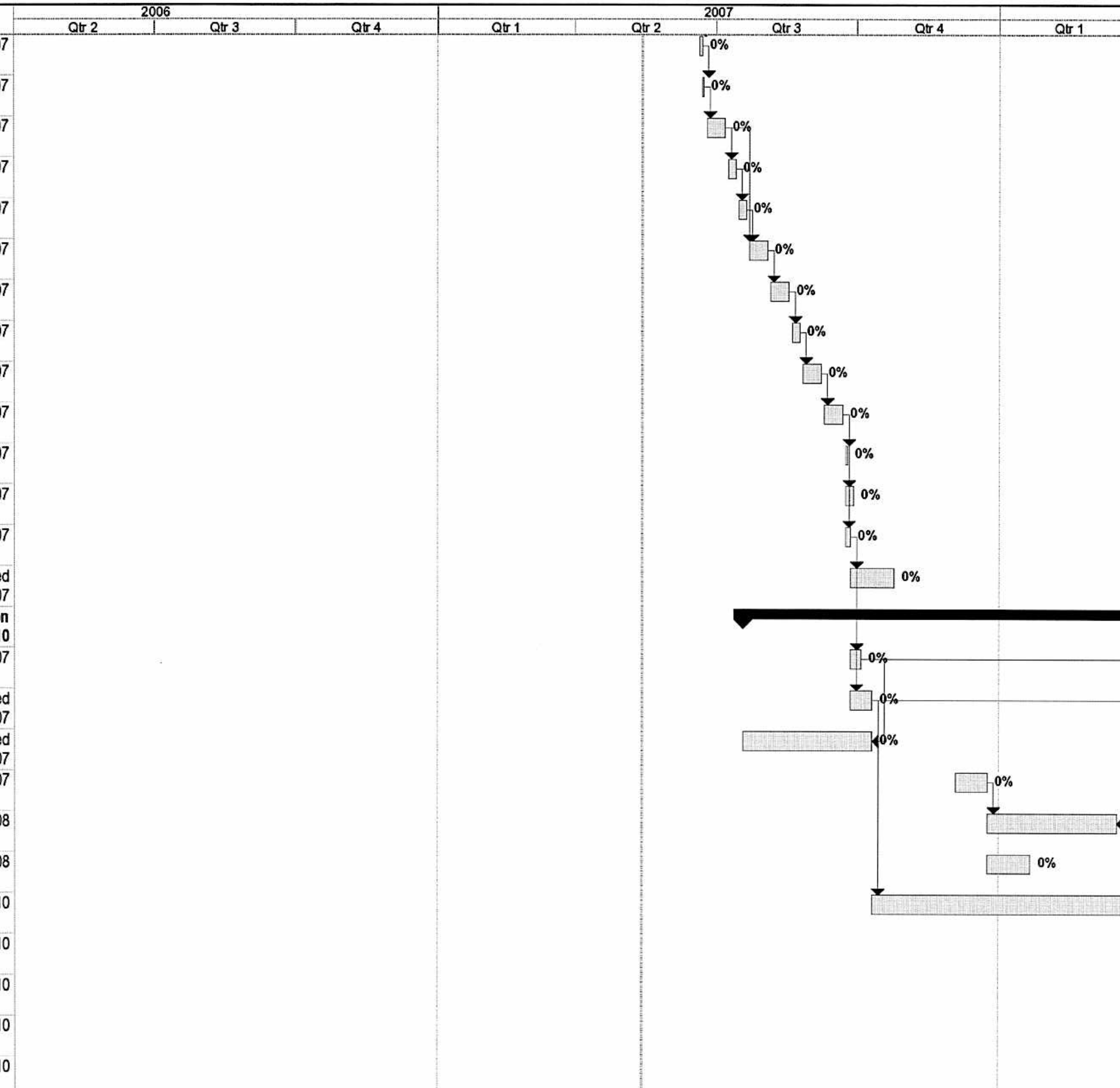


MACTEC

Corrective Action Implementation Schedule PLATE
Corrective Action Implementation Work Plan
Building 1065 Area
Presidio of San Francisco, California
8-1a

DRAWN	JOB NUMBER	CHECKED	CHECKED DATE	APPROVED	APPROVED DATE
CN	4089030006 00311	[signature]	05/07	SUK	5/07

ID	Unique ID	Task Name	Duration	Planned Start	Planned Finish
42	99	Concrete Slab Demolition at B1065	2 days	Wed 6/20/07	Thu 6/21/07
43	100	Initial Excavation / Test Trenching at B1065	1 day	Fri 6/22/07	Fri 6/22/07
44	101	Initial Confirmation Soil Sampling & Analysis at B1065	2 wks	Mon 6/25/07	Fri 7/6/07
45	102	Building Column Removal & Shoring at B1065	1 wk	Mon 7/9/07	Fri 7/13/07
46	103	Mezzanine Demo at B1065	1 wk	Mon 7/16/07	Fri 7/20/07
47	104	Final Excavation / Main Soil Excavation Activities at B1065	2 wks	Mon 7/23/07	Fri 8/3/07
48	105	Confirmation Sampling & Analysis at B1065	2 wks	Mon 8/6/07	Fri 8/17/07
49	106	Additional Excavation (If Needed) at B1065	1 wk	Mon 8/20/07	Fri 8/24/07
50	107	Confirmation Sampling and Analysis (If Needed) at B1065	2 wks	Mon 8/27/07	Fri 9/7/07
51	108	Waste Profiling and Analysis at B1065	2 wks	Mon 9/10/07	Fri 9/21/07
52	149	ORC Application	1 day	Mon 9/24/07	Mon 9/24/07
53	109	Transportation and Disposal at B1065	1 wk	Mon 9/24/07	Fri 9/28/07
54	110	Backfill and Compaction at B1065	3 days	Mon 9/24/07	Wed 9/26/07
55	111	Re-install Columns & Remove Shoring at B1065	4 wks	Thu 9/27/07	Wed 10/24/07
56	**112**	**Post Construction at B1065**	**868 days**	**Thu 7/19/07**	**Mon 11/15/10**
57	113	Post Construction Survey at B1065	1 wk	Thu 9/27/07	Wed 10/3/07
58	114	Water Sampling at B1065	2 wks	Thu 9/27/07	Wed 10/10/07
59	116	Prepare CAP Completion Report for B1065	12 wks	Thu 7/19/07	Wed 10/10/07
60	122	Revise/Finalize Completion Report for B1065 for Agencies	15 days	Tue 12/4/07	Mon 12/24/07
61	115	Prepare LUCMMR Addenda for B1065	12 wks	Tue 12/25/07	Mon 3/17/08
62	123	RWQCB/DTSC Issues Construction Completion Letter for B1065	20 days	Tue 12/25/07	Mon 1/21/08
63	125	Clean Closure Compliance Monitoring (720days) at B1065	720 days	Thu 10/11/07	Wed 7/14/10
64	128	Prepare Internal Draft Site Closure/Certification Report for B1065	10 days	Thu 8/19/10	Wed 9/1/10
65	132	External Review of Draft Site Closure/Certification Report for B1065	20 days	Tue 9/28/10	Mon 10/25/10
66	133	Revise/Finalize Site Closure/Certification Report for B1065	10 days	Tue 10/26/10	Mon 11/8/10
67	134	RWQCB Approval of Site Closure/Certification Report for B1065	5 days	Tue 11/9/10	Mon 11/15/10



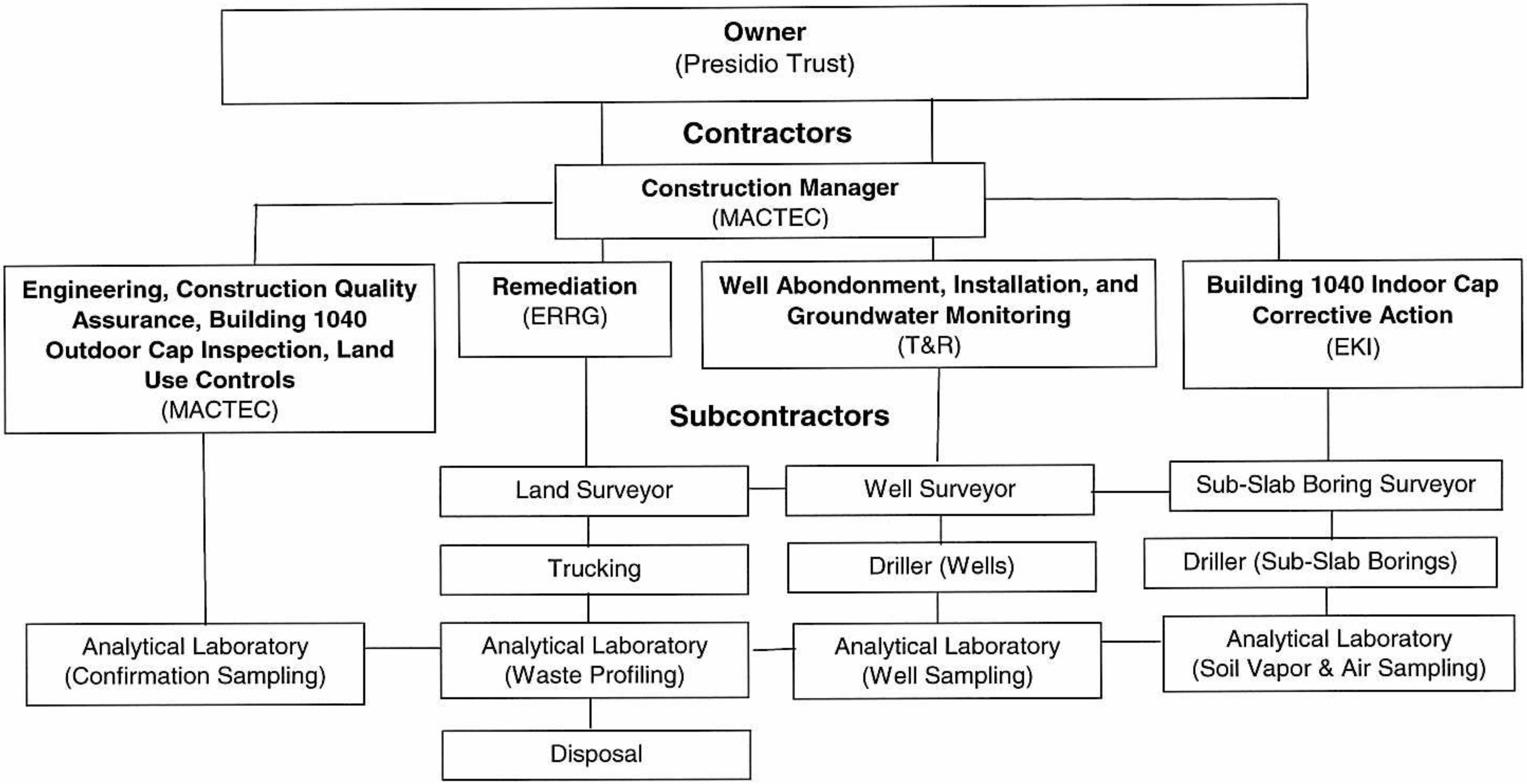
MACTEC

Corrective Action Implementation Schedule PLATE
Corrective Action Implementation Work Plan
Building 1065 Area
Presidio of San Francisco, California

8-1b

DRAWN	JOB NUMBER	CHECKED	CHECKED DATE	APPROVED	APPROVED DATE
CN	4089030006 00311		05/07	SUK	5/07

CHARTS



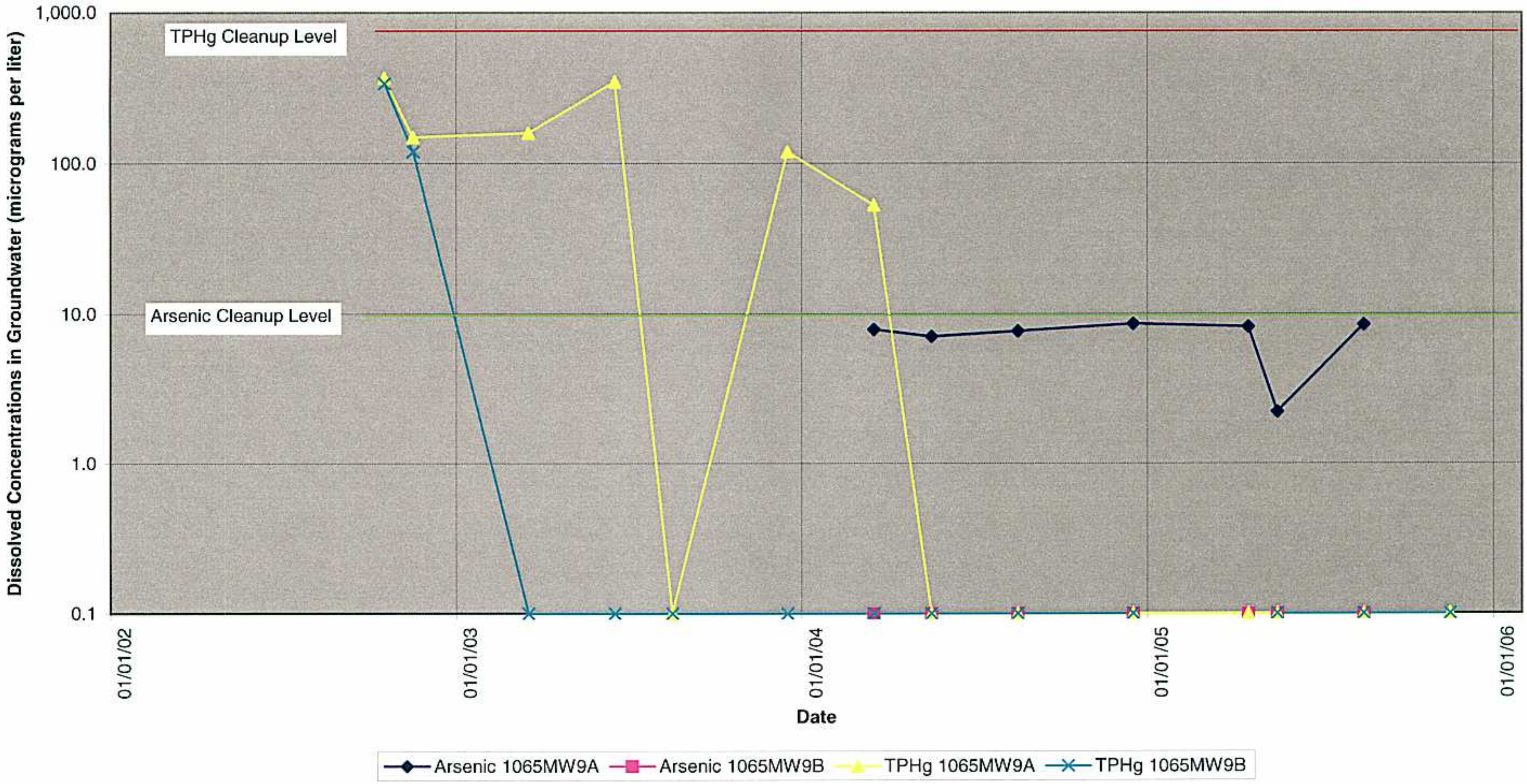
MACTEC

Organization Chart of Corrective Action Contracting

Corrective Action Implementation Work Plan
Building 1065 Area
Presidio of San Francisco, California

Chart 1-1

DRAWN	JOB NUMBER	APPROVED	CHECKED	DATE	REVISED DATE
MLS	4089030006 00311	JW	SG	5/07	5/17/2007



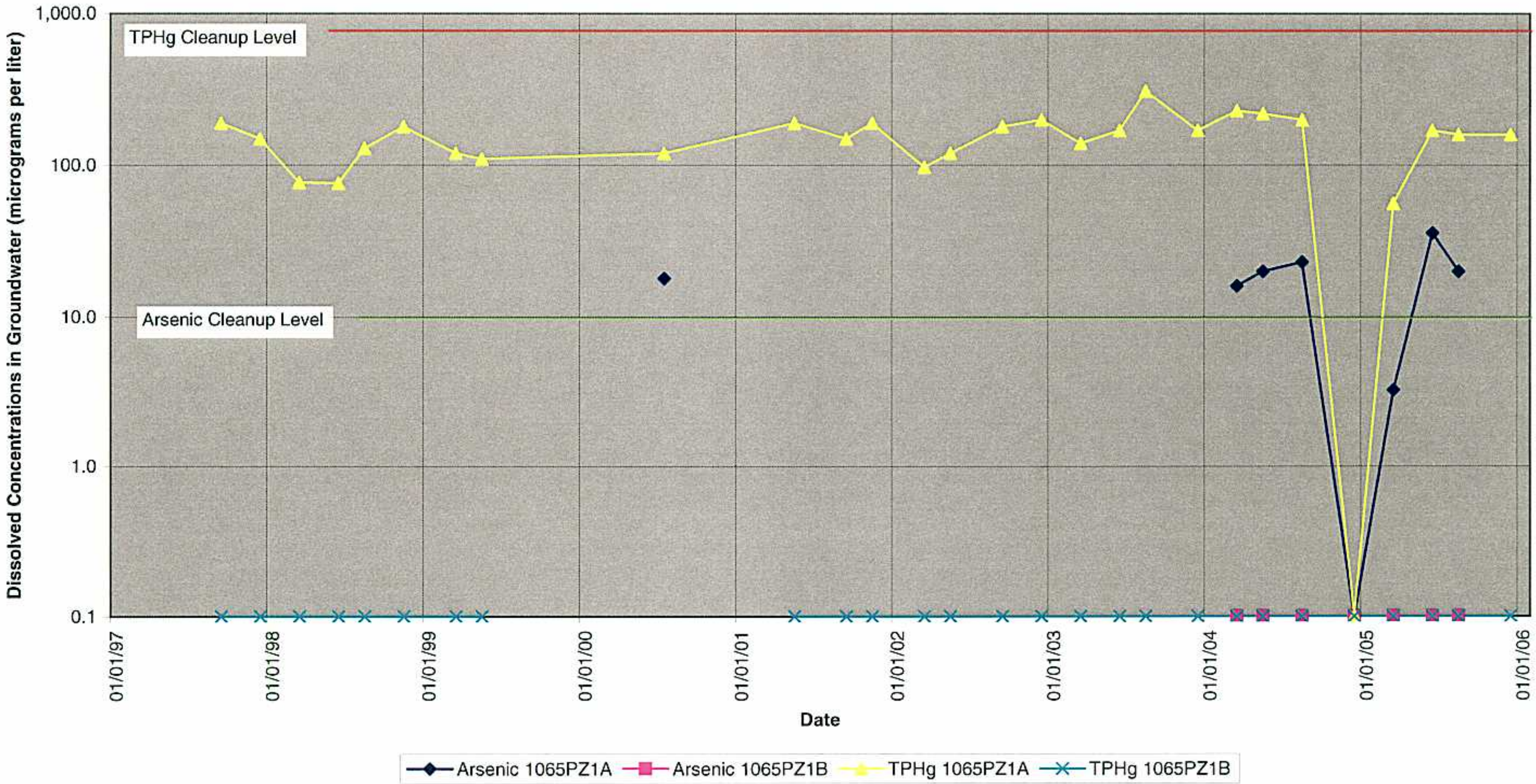
MACTEC

Dissolved Concentrations of TPHg and Arsenic in Groundwater
1065MW9A and 1065MW9B

Chart
4-1

Corrective Action Implementation Work Plan
Building 1065 Area
Presidio of San Francisco, California

DRAWN	JOB NUMBER	APPROVED	CHECKED	DATE	REVISED DATE
SRG	4089030006 00311	SLK		5/07	5/18/2007



MACTEC

Dissolved Concentrations of TPHg and Arsenic in Groundwater
1065PZ1A and 1065PZ1B

Chart 4-2

Corrective Action Implementation Work Plan
Building 1065 Area
Presidio of San Francisco, California

DRAWN	JOB NUMBER	APPROVED	CHECKED	DATE	REVISED DATE
SRG	4089030006 00311	SUK		5/07	5/18/2007

APPENDIX A

STANDARD OPERATING PROCEDURES (SOPS) FOR WELL MAINTENANCE AND ABANDONMENT

REVIEWED BY: Srk ____________________

1.0 BACKGROUND

The physical condition of all monitoring wells should be assessed, and if problems are discerned, proper well maintenance should be conducted. Well maintenance can include well redevelopment, wellhead repair, wellhead security, additional casing extension, and elevation surveying, as necessary. Well redevelopment may be necessary if the well was incorrectly or insufficiently developed after installation or the well was installed in a very low groundwater recharge area. It also may require redevelopment if it has not been pumped in the previous 12 months. If the wellhead has been damaged in any way, the wellhead will need to be repaired and the casing elevation may need resurveying.

Improperly constructed or unused monitoring wells should be properly abandoned (decommissioned) for at least one of the following reasons: (1) to eliminate physical hazards, (2) to prevent groundwater contamination migration or contamination from the ground surface to the water table or between aquifers, (3) to conserve aquifer yield and hydrostatic head, and (4) to prevent mixing of subsurface water. When a decision is made to abandon a monitoring well, the borehole should be abandoned according to specific guidelines. To properly abandon a well, the preferred method is to completely remove the well casing and screen from the borehole, clean out the borehole, and backfill with a cement or bentonite grout, neat cement, or concrete. Another option is to completely fill the entire borehole from the bottom up with grout to within a few (5 or less) feet of ground surface and backfill the uppermost feet with clean fill material. In order to comply with California well abandonment requirements, a permit for monitoring well destruction should be obtained from the City and County of San Francisco, Department of Public Health, Bureau of Environmental Health Management (On-line address: http://www.dph.sf.ca.us/ehs/water/Monitoring_wells/index.htm).

1.1 PURPOSE

This standard operating procedure (SOP) establishes the requirements and procedures for well maintenance and properly abandoning monitoring wells.

1.2 SCOPE

This SOP describes procedures for well maintenance and abandonment.

1.3 DEFINITIONS

Specific Capacity: The yield (pumping rate) of a well per unit drawdown, usually expressed as gallons of water per minute per foot of drawdown (gpm/ft) after a given amount of time has elapsed.

1.4 REFERENCES

American Society for Testing Materials (ASTM). 1992. "Standard Guide for Decommissioning of Ground Water Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities." D 5299-92. *1993 Annual Book of ASTM Standards*. Philadelphia, Pennsylvania. Pages 1,318 through 1,333.

California Department of Water Resources (DWR). 1981. "Water Well Standards." Bulletin 74-81. December.

DWR. 1991. "California Well Standards." Bulletin 74-90. June.

California Environmental Protection Agency. 1995. "Monitoring Well Design and Construction for Hydrogeologic Characterization." *Guidance Manual for Ground Water Investigations*. July.

U.S. Environmental Protection Agency. 1996. "Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM)." Region 4 Science and Ecosystem Support Division Enforcement and Investigations Branch. May. Includes 1997 Revisions.

1.5 REQUIREMENTS AND RESOURCES

There are various options available to abandon monitoring wells. The procedures and equipment required are outlined in the following sections for well maintenance and abandonment.

2.0 PROCEDURES

The following sections describe the procedures involved with well maintenance including well redevelopment, well head repair, and well resurveying. The final section describes the procedures for the preferred method for well abandonment at the Presidio.

2.1 WELL REDEVELOPMENT

Well redevelopment should be performed when it is necessary to improve the well yield, remove sediments that have accumulated in the well, and minimize turbidity. Water should be bailed from the monitoring well to remove heavier sediments that may have accumulated at the bottom of the well casing. A surge block (approximately the same diameter as the well casing) should then be inserted into the

casing and used to agitate the well groundwater and cause finer sediments to be drawn from the well filter pack. If the well is dry or is very slow to recharge, then water may have to be introduced to assist in effective surging. Surging should continue for approximately 3 minutes for each foot of screen. Following the first surging period, another period of bailing the well should be performed to remove the dislodged sediments, and a second surging period should be performed. Once the second period of surging is complete and the well has a relatively high yield, a submersible pump should be lowered into the well to purge the water from the well. Pumping should begin at the top of the saturated portion of the well screen and continued to be lowered at 2 foot intervals until the pump is approximately 1 foot from the bottom of the well casing. The water level drawdown and pumping rate should be measured and recorded continuously to calculate specific capacity at each measurement. Purging with the pump should continue until the turbidity is less than or equal to 5 nephelometric turbidity units (NTU) using a turbidity meter. After the turbidity has reached a level of less than or equal to 5 NTUs, repeat the surging and purging until the turbidity meets this level a second time (or 4 hours have elapsed). Finally, specific capacity will be calculated to determine whether well performance criteria have been met.

2.2 WELL HEAD REPAIR

The status of the well head completions, including the condition of well vaults, concrete pads, surface seals and locks and caps should be assessed on an annual basis. The status of the well head integrity and any damage should be recorded and necessary repairs should be implemented. Any debris generated during repair should be treated as construction debris, not investigation derived waste, and disposed of appropriately. All completed repairs should be recorded and reported on.

2.3 WELL RESURVEYING

All monitoring wells should be surveyed upon installation following the requirements stated in SOP No. 013. If existing monitoring wells experience change in the casing elevations during well head repair or other events (such as major earthquakes), they should be resurveyed. If the survey coordinates of existing monitoring wells were found to be measured without following the requirements outlined in SOP No. 013, the wells should be resurveyed.

2.4 WELL ABANDONMENT

A technically sound well abandonment method should be designed based on the site geology, well casing materials, and general condition of the well(s). As previously stated the preferred method for

abandonment will be to completely destroy and remove the well casing and screen from within the borehole. Regardless of the method used, well abandonment should be performed following applicable California regulations (DWR 1981, 1991). This may be accomplished by augering with a hollow-stem auger over the well casing down to the bottom of the borehole, thereby removing the grout and filter pack materials from the hole. The well casing and well screen should then be removed from the borehole with the drill rig. The clean borehole can then be backfilled with the appropriate grout material. The backfill material should be placed into the borehole from the bottom to the top by pressure grouting with the positive displacement method (tremie method). At all times, the opening of the tremie pipe should be submerged several feet below the level of the grout in the borehole.

The top 2 feet of the borehole should be poured with concrete to insure a secure surface seal (plug). If the area has heavy traffic use, and/or the well locations need to be permanently marked, then an asphalt patch should be installed to cover the concrete. The concrete surface plug can also be recessed below ground surface if the potential for construction activities exists.

This abandonment method can be accomplished on small diameter (1- to 4-inch) wells without too much difficulty. With wells having 6-inch or larger diameters, the use of hollow-stem augers for casing removal is very difficult or almost impossible. Instead of trying to ream the borehole with a hollow-stem auger, it is more practical to force a drill stem with a tapered wedge assembly or a solid-stem auger into the well casing and extract it out of the borehole. Wells with little or no grouted annular space or sound well casings can be removed in this manner. However, old wells with badly corroded casings or thickly grouted annular space have a tendency to twist and/or break-off in the borehole. When this occurs, the well will have to be grouted with the remaining casing left in the borehole. The preferred method in this case should be to pressure grout the borehole by placing the tremie tube to the bottom of the well casing, which will be the well screen or the bottom sump area below the well screen. The pressurized grout will be forced out through the well screen into the filter material and up the inside of the well casing sealing holes and breaks that are present. The tremie tube should be retracted slowly as the grout fills the casing. The well casing should be cut off even with the ground surface and filled with concrete to a depth of 2 feet below the surface. If the casing has been broken off below the surface, the grout should be tremied to within 2 feet of the surface and then finished to the ground surface with concrete. The surface pad or specified surface restoration shall then be installed.

A polyvinyl chloride (PVC) well casing may be more difficult to remove from the borehole than a metal casing, because of its brittleness. If the PVC well casing breaks during removal, the borehole should be

cleaned out by using a drag bit or roller cone bit with the mud rotary method to grind the casing into small cuttings that will be lifted out of the borehole by drilling mud. Another method is to use a solid-stem auger with a carbide tooth bit to grind the PVC casing into small cuttings that will be brought to the surface on the rotating flights. After the casing materials have been removed from the borehole, the borehole should be cleaned out and pressure grouted with the approved grouting materials. As previously stated, the borehole should be finished with a concrete surface plug and adequate surface restoration, unless directed otherwise.

APPENDIX B

STANDARD OPERATING PROCEDURES (SOPS) FOR SAMPLING AND WELL INSTALLATION ACTIVITIES

REVIEWED BY: SK

SOP APPROVAL FORM

THE PRESIDIO TRUST

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

SOIL SAMPLING

SOP NO. 001

REVISION NO. 00

Last Reviewed: December 2000

Quality Assurance Approved

12 JAN 01

Date

1.0 BACKGROUND

Soil sampling is conducted for three main reasons. First, samples can be obtained for laboratory chemical analysis. Second, samples can be obtained for laboratory physical analysis. Third, samples can be obtained for visual classification and field screening. These three sampling objectives can be achieved separately or in combination with each other. Sampling locations are typically chosen to provide chemical, physical, or visual information in both the horizontal and vertical directions. A sampling and analysis plan is used to outline sampling methods and provide preliminary rationale for sampling locations. Sampling locations may be adjusted in the field based on the screening methods being used and the physical features of the area.

1.1 PURPOSE

Soil sampling is conducted to determine the chemical, physical, and visual characteristics of surface and subsurface soils.

1.2 SCOPE

This standard operating procedure (SOP) describes procedures for soil sampling in different areas using various implements. It includes procedures for test pit, surface soil, and subsurface soil sampling, and describes eight devices. It also discusses procedures for collecting soil samples for volatile organic compound (VOC) analysis using the EnCore™ soil sampler system.

1.3 DEFINITIONS

Hand Auger: Instrument attached to the bottom of a length of pipe that has a crossarm or "T"-handle at the top. The auger can be closed-spiral or open-spiral.

Bucket Auger: A type of auger that consists of a cylindrical bucket 10 to 72 inches in diameter with teeth arranged at the bottom.

Core Sampler: Thin-wall cylindrical metal tube with diameter of 0.5 to 3 inches, a tapered nosepiece, a T-handle to facilitate sampler deployment and retrieval, and a check valve (flutter valve) in the headpiece.

Spatulas or Spoons: Stainless steel instruments for collecting loose unconsolidated material.

Trier: Tube cut in half lengthwise with a sharpened tip that allows for collection of sticky solids or loosening of cohesive soils.

Trowel: Tool with a scooped blade 4 to 8 inches long and 2 to 3 inches wide and has a handle.

Split-Spoon (or Split-Barrel) Sampler: Thick-walled steel tube that is split lengthwise. A cutting shoe is attached to the lower end; the upper end contains a check valve and is connected to drill rods.

Thin-Wall Tube Sampler: Steel tube (1 to 3 millimeters thick) with tapered bottom edge for cutting. The upper end is fastened to a check valve that is attached to drill rods.

1.4 REFERENCES

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EPA. 1994. "Soil Sampling." Environmental Response Team SOP No. 2012. Revision No. 0.0. November 16. (On-Line Address: http://www.ert.org/media_resrcs/media_resrcs.asp.)

1.5 REQUIREMENTS AND RESOURCES

Soil sampling requires that one or more of the following types of equipment be used:

Sampling Equipment	Other Required Equipment
Spoons and spatulas	Sample containers, labels, and chain-of-custody forms
Trowel	Logbook
Shovel or spade	Measuring tape
Trier	Soil classification guidelines
Core sampler	Wax for sealing ends of thin-wall tube

Hand auger
Bucket auger
Split-spoon
Thin-wall tube
Plastic sheeting
Decontamination equipment
Drilling equipment
Backhoe
Health and safety equipment

2.0 PROCEDURES

This SOP presents procedures for conducting test pit, surface soil, and subsurface soil sampling. The project-specific field sampling plan will specify which of the following procedures will be used.

Soil samples for chemical analysis should be collected in the following order: (1) VOCs, (2) semivolatile organic compounds, and (3) metals. Once the chemical samples have been containerized, samples for physical analyses can be containerized. Typical physical analyses conducted include (1) grain size distribution, (2) moisture content, (3) saturated permeability, (4) unsaturated permeability, and (5) Atterberg limits. Additionally, visual descriptions of samples, using the Unified Soil Classification System (USCS), should be recorded. Soil samples for chemical analyses can be collected either as grab samples or composite samples. A grab sample is collected from a discrete location or depth. A composite sample consists of soil combined from more than one discrete location. Typically, composite samples consist of soil obtained from several locations and homogenized in a stainless steel or Teflon® pan or tray. Samples for VOC analysis should not be composited.

2.1 TEST PIT SOIL SAMPLING

Test pit soil sampling is conducted when a complete soil profile is required or as a means of locating visually detectable contamination or sources, such as debris and underground storage tanks. This type of sampling provides a detailed description of the soil profile and allows for multiple samples to be collected from specific soil horizons. Before conducting any test pit or trench excavation with a backhoe, the sampling team should ensure that the sampling area is clear of utility lines, subsurface pipes, and poles. Any intrusive activities require Trust project review and permit issuance.

A test pit or trench is excavated by incrementally removing soil material with a backhoe bucket. The excavated soil may be placed on plastic sheeting (or other means of segregation), well away from the edge of the test pit. A test pit with depths greater than 4 feet must have its walls properly stabilized

according to Occupational Safety and Health Administration standards if personnel access to the pit is required. In many applications, sampling from the backhoe bucket will be preferred.

Personnel entering the test pit may be exposed to toxic or explosive gases and oxygen deficient environments. Air monitoring is required before entering the test pit and the use of appropriate respiratory gear and protective clothing is mandatory. At least two persons must be present at the test pit before sampling personnel enter the excavation and begin soil sampling.

Test pits are not practical for depths greater than 15 feet. If soil samples are required from depths greater than 15 feet, samples should be obtained using test borings instead of test pits. Test pits are also usually limited to a few feet below the water table. In some cases, a pumping system may be required to control the water level within the pits.

Access to open test pits should be restricted by use of flagging, tape, or fencing. If a fence is used, it should be erected at least 6 feet from the perimeter of the test pit. The test pit should be backfilled as soon as possible after sampling is completed.

Soil samples can be collected from the walls or bottom of a test pit using various equipment. A hand auger, bucket auger, or core sampler can be used to obtain samples from various depths. A trier, trowel, or spoons can be used to obtain samples from the walls or pit bottom surface.

2.2 SURFACE SOIL SAMPLING

The surface (and near surface) soil sampling equipment presented in this SOP is best suited for sampling to depths of 0 to 6 feet below ground surface (bgs). The sample depth, sample analyses, soil type, and soil moisture will also dictate the best-suited sampling equipment. Before sample collection, the sampling locations should be cleared of any surface debris such as twigs, rocks, and litter. The following table presents various surface soil sampling equipment and their effective depth ranges, operating means (manual or power), and sample types collected (disturbed or undisturbed).

Sampling Equipment	Effective Depth Range (feet bgs)	Operating Means	Sample Type
Hand Auger	0 to 6	Manual	Disturbed
Bucket Auger	0 to 4	Power	Disturbed
Core Sampler	0 to 4	Manual or Power	Undisturbed

Shovel	0 to 6	Manual	Disturbed
Trier	0 to 1	Manual	Disturbed
Trowel	0 to 1	Manual	Disturbed
Spoon/Spatula	0 to 0.5	Manual	Disturbed

The procedures for using these various types of sampling equipment are discussed below.

2.2.1 Hand Auger

A hand auger equipped with extensions and a T-handle is used to obtain samples from a depth of up to 6 feet below ground surface. If necessary, a shovel may be used to excavate the topsoil to reach the desired subsoil level. If topsoil is removed, its thickness should be recorded. Samples obtained using a hand auger are disturbed in their collection; determining the exact depth at which samples are obtained is difficult.

The hand auger is screwed into the soil at an angle of 45 to 90 degrees from horizontal. When the entire auger blade has penetrated soil, the auger is removed from the soil by lifting it straight up without turning it, if possible. If the desired sampling depth has not been reached, the soil is removed from the auger and deposited onto plastic sheeting. This procedure is repeated until the desired depth is reached and the soil sample is obtained. The auger is then removed from the boring and the soil sample is collected directly from the auger into an appropriate sample container.

2.2.2 Bucket Auger

A bucket auger, equipped similarly as the hand auger, is used to obtain disturbed samples from a depth of up to 4 feet. A bucket auger should be used when sampling stony or dense soil that prohibits the use of a hand-operated core or screw auger. A bucket auger with closed blades is used in soil that cannot generally be penetrated or retrieved by a core sampler.

The bucket auger is rotated while downward pressure is exerted until the bucket is full. The bucket is then removed from the boring, the collected soil is placed on plastic sheeting, and this procedure is repeated until the appropriate depth is reached and a sample is obtained. The bucket is then removed from the boring and the soil sample is transferred from the bucket to an appropriate sample container.

2.2.3 Core Sampler

A hand-operated core sampler (Figure 1), similarly equipped as the hand auger, is used to obtain samples from a depth of up to 4 feet in uncompacted soil. The core sampler is capable of retrieving undisturbed soil samples and is appropriate when low concentrations of metals or organics are of concern. The core sampler should be constructed of stainless steel. A polypropylene core sampler is generally not suitable for sampling dense soils or sampling at an appreciable depth.

The core sampler is pressed into the soil at an angle of 45 to 90 degrees from horizontal and is rotated when the desired depth is reached. The core is then removed, and the sample is placed into an appropriate sample container.

2.2.4 Shovel

A shovel may be used to obtain large quantities of soil that are not readily obtained with a trowel but is not recommended. A shovel is used when soil samples from a depth of up to 6 feet are to be collected by hand excavation; a tiling spade (sharpshooter) is recommended for excavation and sampling. A standard steel shovel may be used for excavation; either a stainless steel or polypropylene shovel may be used for sampling. Soil excavated from above the desired sampling depth should be stockpiled on plastic sheeting. Soil samples should be collected from the shovel and placed into the sample container using a stainless-steel scoop, plastic spoon, or other appropriate tool.

2.2.5 Trier

A trier (Figure 2) is used to sample soil from a depth of up to 1 foot. A trier should be made of stainless steel or polypropylene. A chrome-plated steel trier may be suitable when samples are to be analyzed for organics and heavy metal content is not a concern.

Samples are obtained by inserting the trier into soil at an angle of up to 45 degrees from horizontal. The trier is rotated to cut a core and is then pulled from the soil being sampled. The sample is then transferred to an appropriate sample container.

2.2.6 Trowel

A trowel is used to obtain surface soil samples that do not require excavation beyond a depth of 1 foot. A trowel may also be used to collect soil subsamples from profiles exposed in test pits. Use of a trowel is practical when sample volumes of approximately 1 pint (0.5 liter) or less are to be obtained. Excess soil should be placed on plastic sheeting until sampling is completed. A trowel should be made of stainless steel (or galvanized steel for samples that are analyzed for metals). It can be purchased from a hardware or garden store. Soil samples to be analyzed for organics should be collected using a stainless steel trowel. Samples may be placed directly from the trowel into sample containers.

2.3 SUBSURFACE SOIL SAMPLING

Subsurface soil sampling, in conjunction with borehole drilling, is required for soil sampling from depths greater than approximately 6 feet. Subsurface soil sampling is frequently coupled with exploratory boreholes or monitoring well installation. Refer to SOP No. 004 for monitoring well installation and borehole drilling procedures. Prior to intrusive soil sampling activities, site utilities may be required to be cleared by a qualified utility locator. As noted previously, intrusive soil activities also require Trust project review and permit issuance.

Subsurface soil sampling may be conducted using a drilling rig or power auger. Selection of sampling equipment depends upon geologic conditions and the scope of the sampling program. Two types of samplers used with machine-driven augers—the split-spoon sampler and the thin-wall tube sampler—are discussed below. All sampling tools should be cleaned before and after each use in accordance with SOP No. 014 (General Equipment Decontamination). Both the split-spoon sampler and the thin-wall tube sampler can be used to collect undisturbed samples from unconsolidated soils. Direct-push methods are commonly used to drive tube samplers equipped with acetate or brass sleeves. Acetate sleeves permit the recovery of a continuous core (typically 4-foot lengths) that can be divided for chemical or other analyses. The procedures for using the split-spoon and thin-wall tube samplers are presented below.

2.3.1 Split-Spoon Sampler

Split-spoon samplers are available in a variety of types and sizes. Site conditions and project needs (such as large sample volume for multiple analyses) determine the specific type of split-spoon sampler to be used. Figure 3 shows a generic split-spoon sampler.

The split-spoon sampler is advanced into the undisturbed soil beneath the bottom of the casing or borehole using a weighted hammer and a drill rod. The relationship between hammer weight, hammer drop, and number of blows required to advance the split-spoon sampler in 6-inch increments indicates the density or consistency of the subsurface soil. After the split-spoon sampler has been driven to its intended depth, it should be removed carefully to avoid loss of sample material. In noncohesive or saturated soil, a catcher or basket should be used to help retain the sample.

After the split-spoon sampler is removed from the casing, it is detached from the drill rod and opened. If VOC samples are to be collected, EnCore™ samplers should be filled with soil taken directly from the split-spoon sampler (see Section 2.4). Samples for other specific chemical analyses should be taken as soon as the VOC sample has been collected. The remainder of the recovered soil can then be used for visual classification of the sample and containerized for physical analysis. The entire sample (except for the top several inches of possibly disturbed material) is retained for analysis or disposal.

2.3.2 Thin-Wall Tube Sampler

A thin-wall tube sampler, sometimes called the Shelby tube (Figure 4), may be pressed or driven into soil inside a hollow-stem auger flight, wash bore casing, or uncased borehole. The tube sampler is pressed into the soil without rotation to the desired depth or until refusal. If the tube cannot be advanced by pushing, it may be necessary to drive it into the soil without rotation using a hammer and drill rod. The tube sampler is then rotated to collect the sample from the soil and removed from the borehole.

After removal of the tube sampler from the drilling equipment, the tube sampler should be inspected for adequate sample recovery. The sampling procedure should be repeated until an adequate soil core is obtained (if sample material can be retained by the tube sampler). The soil core obtained should be documented in the logbook. Any disturbed soil is removed from each end of the tube sampler. If chemical analysis is required, VOC samples must be collected immediately after the tube sampler is withdrawn (see Section 2.4). Before use, and during storage and transport, the tube sampler should be capped with a nonreactive material. For physical sampling parameters, the tube sampler should be sealed by pouring three 0.25-inch layers of sealing liquid (such as wax) in each end, allowing each layer to solidify before applying the next. The remaining space at each end of the tube is filled with Ottawa sand or other, similar sand, which is allowed to settle and compact. Plastic caps are then taped over the ends of the tube. The top and bottom of the tube sampler should be labeled and the tube sampler should be stored accordingly.

2.4 ENCORE™ SOIL SAMPLER SYSTEM FOR VOC ANALYSES

The EnCore™ soil sampler system is a dedicated system designed to collect, store, and deliver an approximately 5- or 25-gram soil sample in a zero-headspace container. The samplers are applicable to the collection of samples for VOC analyses (including chlorinated and aromatic VOCs and purgeable total petroleum hydrocarbons). No preservation chemicals are needed in the field. Extrusion and extraction of the whole sample in the sampler is done in the laboratory. No subsampling of the individual container is necessary. The EnCore™ sampler is a single use device and cannot be cleaned or reused. The EnCore™ system consists of the following four components:

- A cartridge with moveable plunger
- A cap with two locking arms
- A T-handle to aid in sampling
- An extrusion handle used in the laboratory

The soil collected in the EnCore™ sampler is stored in a sealed, headspace-free state. Three Viton "O"-rings achieve the seals (two located on the plunger and one on the cap of the sampler). For correct sealing, these O-rings must not be removed or disturbed.

The following procedures should be followed to collect a soil sample with the EnCore™ sampler:

- Before collecting the sample, hold the coring body and push the plunger rod down until small rod rests against the tabs (to ensure that the plunger moves freely). Then, depress locking lever on T-handle and place the coring body, plunger end first, into the open end of the T-handle, aligning the two slots on the coring body with the two locking pins in the T-handle. Twist the coring body clockwise to lock the pins in the slot. Check to ensure sampler is locked in place.

- Turn the T-handle such that the "T" is up and the coring body is down. This position leaves the plunger body flush with the bottom of the coring body. Holding the T-handle, push and twist the sampler into the soil until the coring body is completely full. When the sampler is full, the small O-ring on the plunger rod will be centered in the T-handle viewing hole (the upper hole for the 25-gram sampler and the lower hole for the 5-gram sampler). Remove the sampler from the soil.

- Before capping the sampler, wipe excess soil from the coring body exterior, ridge area, and any soil that may protrude beyond the opening end of the coring body to ensure proper sealing. Cap the coring body while it is still on the T-handle. Continue as above until three samples have been collected from the location. If only VOCs are to be analyzed for a given location, a small jar (minimum 2 ounce) of sample must be collected to allow for moisture content analysis.

When sampling surface soils, apply the EnCore™ sampler to a freshly exposed soil surface, following the procedures described above. When sampling subsurface soils, EnCore™ samples should be collected from one of the open ends of a sleeve core immediately upon retrieval.

The EnCore™ sampling system cannot be reliably used as stated above to sample sand, loose soil, or sediment since a cohesive plug will not be formed with these materials. When working with these soils, pull the plunger all the way back and lock it. Turn the sampler upside down and scoop the material into the coring body and cap it. Make a note of this method deviation in the field notebook.

Place the three collocated samples for each VOC analysis into one zipper bag. Seal the bag, place it into a prechilled cooler maintained at 4°C, and ship the samples to the laboratory for preservation and analysis. The recommended holding time between sampling and preservation by the laboratory is 48 hours. The recommended holding time between preservation and analysis is 14 days. The laboratory will preserve two EnCore™ containers using sodium bisulfate and one container using methanol. This allows for both low-level and high-level analysis of the sample.

FIGURE 1

HAND-OPERATED CORE SAMPLER

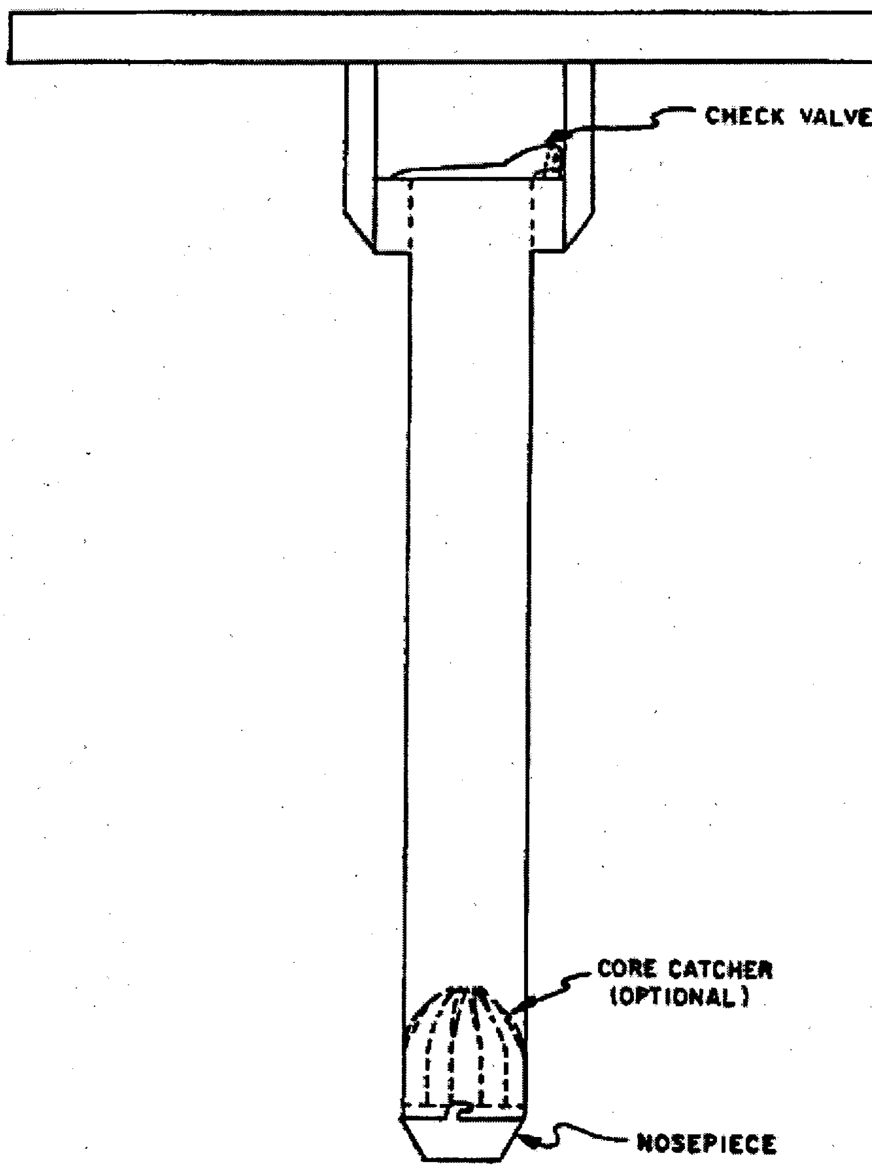


FIGURE 2

TRIER

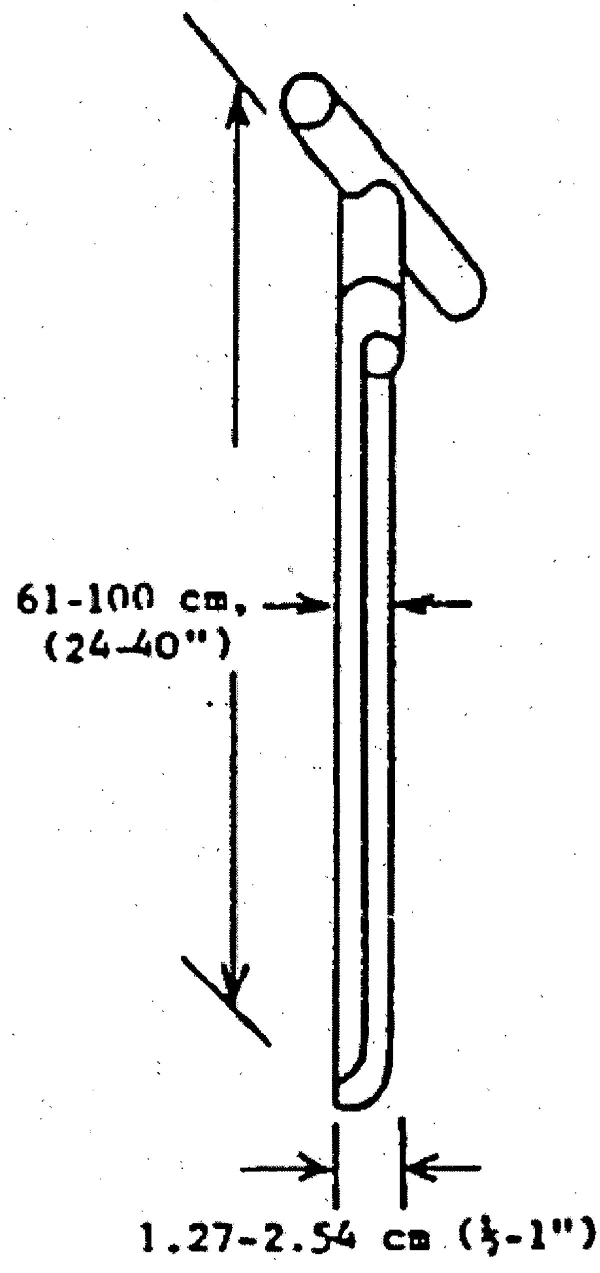


FIGURE 3

GENERIC SPLIT-SPOON SAMPLER

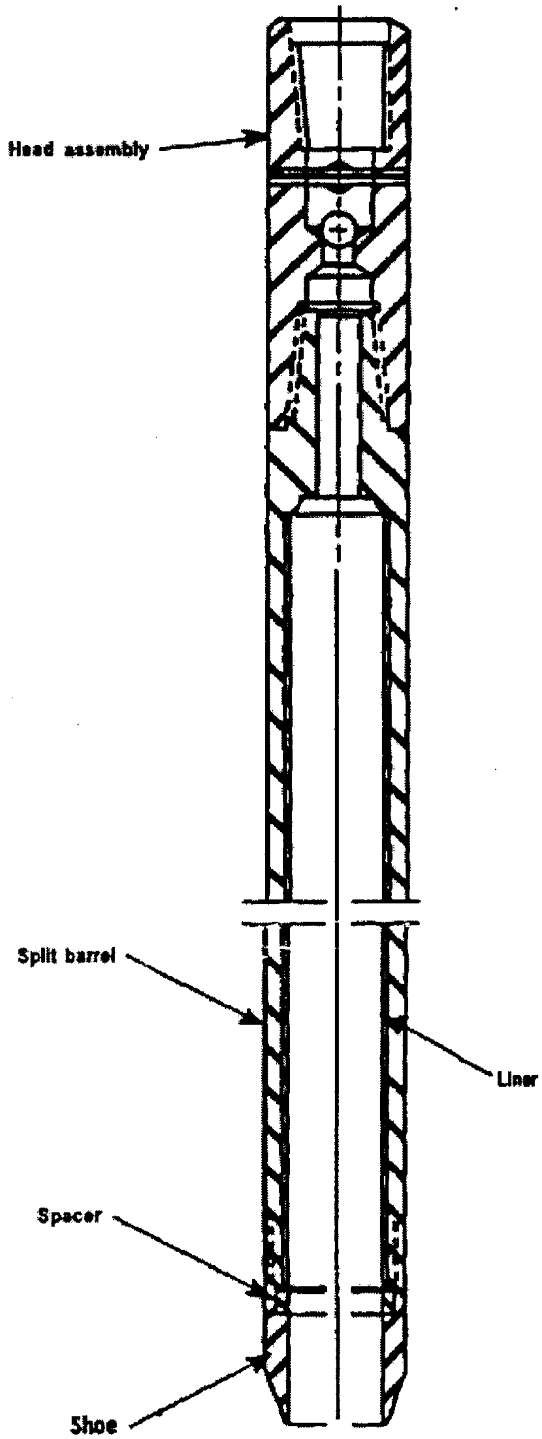
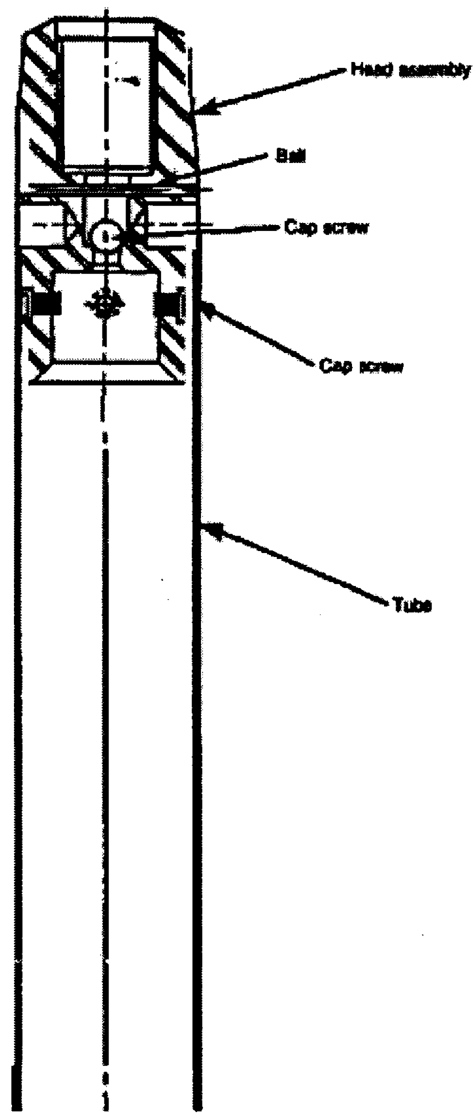


FIGURE 4

THIN-WALL TUBE SAMPLER



1.0 BACKGROUND

Well type, well construction, and well installation methods will vary with drilling method, well utility, subsurface characteristics, or other site-specific criteria. Specifications for well installation will be identified within a project-specific field sampling plan (FSP). A Monitoring Well Installation Record (Attachment A) will be completed for each well installed.

Well installation methods will depend somewhat on the boring method. In turn, the boring method will depend on site-specific geology and hydrogeology. Boring methods include:

- Hollow-stem auger
- Cable tool
- Rotary (mud, reverse, or air)
- Rock coring
- Direct push methods

The hollow-stem auger method is preferred in areas where subsurface materials are unconsolidated or loosely consolidated and where the depth of the boring will be generally less than 100 feet. This maximum depth is dependent on the diameter of the augers, the formation characteristics, and the strength and durability of the drilling equipment. This method is preferred because it is quick and inexpensive, addition of water into the subsurface is limited, and continuous samples can easily be collected.

Cable tool drilling is a preferred method when the subsurface contains boulders, coarse gravels, or flowing sands, or when the operational depth of the hollow-stem auger is exceeded. This method, however, is slow.

Rotary methods are generally used when other methods cannot be used. The use of drilling fluids or large amounts of water to maintain an open borehole, and the difficulty in obtaining representative samples limit this method's utility. However, this method can be used to quickly and effectively drill deep wells through consolidated or unconsolidated materials. Modifications of this method such as dual-tube drilling, drill-through casing hammers, or eccentric type drill systems can reduce the amount of fluids introduced into the well borehole.

Rock coring is an effective method when drilling in competent consolidated rock. Intact, continuous cores can be obtained, and limited amounts of fluid are required if the formations are not fractured.

Direct-push methods can be used to install shallow, water table well points in unconsolidated soils. Direct-push methods have the advantage of being rapid and relatively inexpensive, but are generally not suitable where flowing sands or consolidated material exist. In addition, this approach frequently produces a significantly more turbid sample than would be obtained from a comparable conventional monitoring well.

1.1 PURPOSE

This standard operating procedure (SOP) discusses general types of wells and minimum standards for well installation.

1.2 SCOPE

This SOP describes procedures for well installation using various methods. It includes procedures applicable to hollow-stem auger, cable tool, rotary (mud, reverse, or air), and rock coring. It also discusses more specialized wells and methods, such as direct-push installation of well points.

1.3 DEFINITIONS

None.

1.4 REFERENCES

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Driscoll, F.G. 1986. *Groundwater and Wells.* Second Edition. Johnson Division, UOP, Inc. St. Paul, Minnesota. Pages 438 through 442.

1.5 REQUIREMENTS AND RESOURCES

There are various options available for well installation depending on the boring method. The procedures and equipment required are outlined in the following sections.

2.0 PROCEDURES

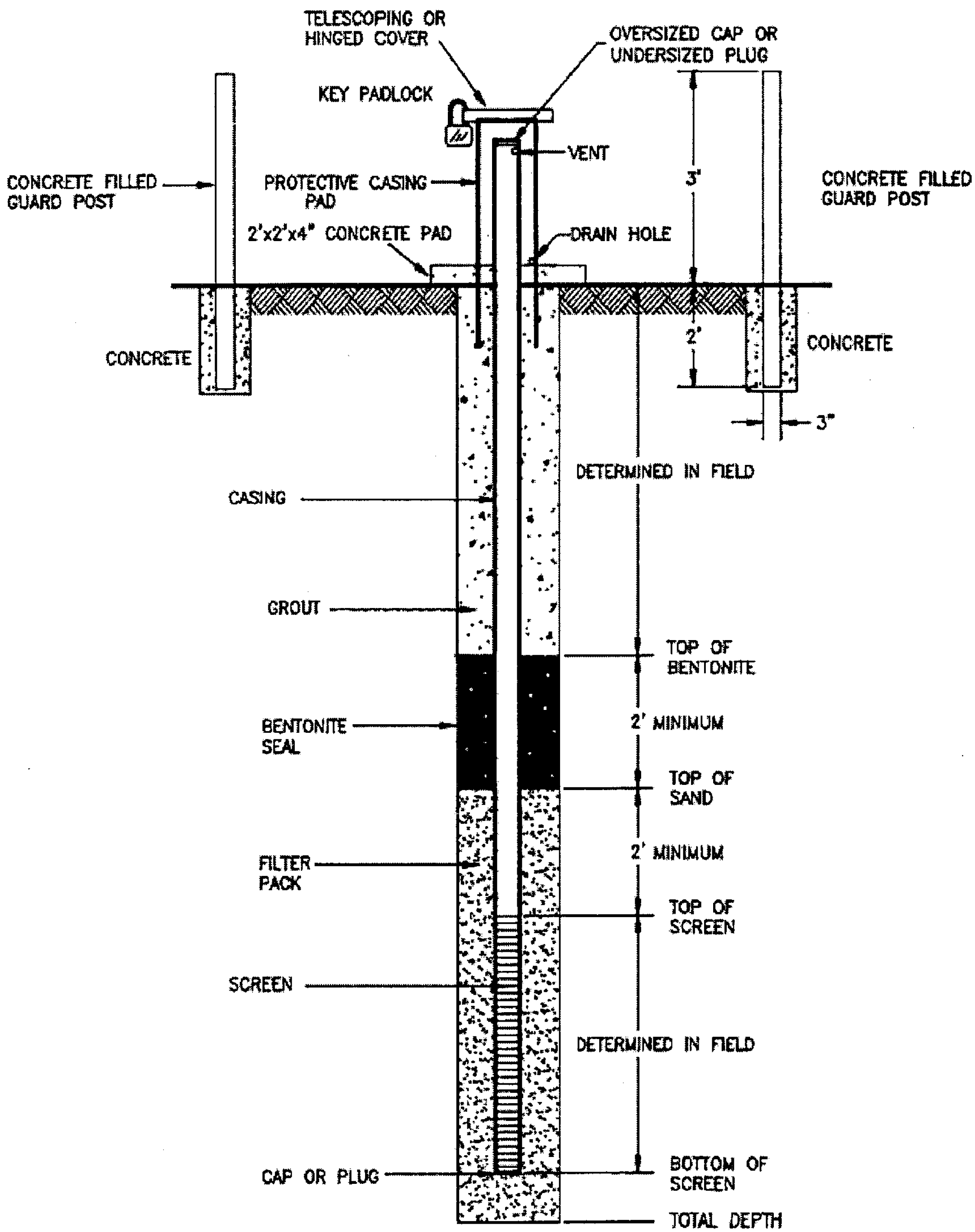
This section details the minimum general monitoring well installation criteria and procedures. Site-specific geologic regimes may result in departures from this procedure. Specific procedures should be detailed in a project-specific FSP. Figure 1 shows a typical completed monitoring well.

All wells will be equipped with factory slotted screen. Casings and screens should be threaded and flush coupled and watertight joints should be used. Casings and screens will be selected in accordance with criteria set forth in Section 2.1. Annular seals are described in Sections 2.2 and 2.3. General monitoring well installation should follow these steps:

1. Before the installation of any casing or screen into the borehole, the casing and screen material should be carefully visually inspected for any cracks, breaks, or other defects. It should then be decontaminated (SOP No. 014 explains decontamination rationale and procedures).
2. Well casing and screens should be anchored within the borehole using centralizers.
3. The filter pack and other annular sealing materials should be installed through the auger stem or borehole casing. A tremie pipe should be used to install this material and a weighted tape should be used to tamp material. The tremie pipe is slowly raised as material is added to the annular space. When wells are constructed in temporary casing such as hollow stem augers the augers should be lifted when 1 to 2 feet of construction material has accumulated in the annulus. The casing should be lifted enough so that the accumulated material settles to within 2 to 4 inches of the bottom of the temporary casing.
4. Screens will be placed within a filter pack. This filter pack will be constructed in the manner detailed in Section 2.2 and will extend a minimum of 2 feet above and no more than 2 feet below the screened interval.
5. A fine sand collar should be installed to 2 feet above the top of the filter pack.
6. A minimum 2-foot thick bentonite slurry seal will be placed above the filter pack.
7. Bentonite cement slurry should be pumped through a tremie pipe into the annular space up to a point approximately 2-feet below the ground surface.
8. A protective outer casing and locking cap should then be placed in the borehole and a cement surface seal should be installed. The cement surface seal will form a pad around the monitoring well.

FIGURE 1

TYPICAL WELL CONSTRUCTION DIAGRAM



2.1 CASINGS AND SCREENS

The selection of well casing and screen materials must take into account environmental factors such as (1) geologic environment, (2) natural geochemical environment, (3) anticipated well depth, and (4) types and concentrations of known or suspected contaminants. Other nonenvironmental factors that will have an impact on the material selection include (1) anticipated life of the monitoring well, (2) drilling and installation methods, (3) cost, and (4) availability.

Inner casings and well screens should be constructed of inert, durable materials. Polyvinyl chloride (PVC) casings and screens will generally be preferred. However, PVC should not be used if the groundwater or soil contaminants react with PVC or if the well life is expected to be relatively long. Stainless steel, polytetrafluoride (Teflon®), and epoxy-fiberglass are sound well construction materials that may be employees in certain sampling environments. Epoxy-fiberglass well construction materials are relatively new to the environmental monitoring field; however, preliminary data suggests they are comparable to stainless steel, but about half the cost. Due to the recent introduction of this material into the groundwater monitoring field, local regulatory authorities should be consulted prior to the use of this material. Several states, U.S. Environmental Protection Agency regions, and U.S. Army Corps of Engineers Districts are using this material as an alternative to stainless steel.

Casing and screen joints should be threaded, and Teflon® tape should be used to assure a tight seal with Teflon® or stainless-steel components. Epoxy-fiberglass and PVC joints typically are fitted with rubber O-rings to provide a tight seal. Teflon® tape may also be applied to these joints to assure a prolonged tight seal. Under no circumstances should joints be glued or solvent sealed.

Screens will be factory-slotted. The screen slot size will be dependent on required flow rates for the well and the texture of the formation. When sieve analysis information is available for well packing material, slot sizes should be capable of retaining 90 percent of the filter pack material (see Section 2.2). When no such information is available, a default screen size of 0.01 inch (No. 10 slot) will be used.

Screen length and well diameter will depend on site-specific considerations. These include intended well use, contaminants of concern, and hydrogeology. Some considerations are as follows:

- Water table wells should have screens of sufficient length and thickness to monitor the water table and provide sufficient sample volume during high and low water table conditions.

- Wells with low recharge should have screens of sufficient length and width so that adequate sample volume can be collected.

- Wells should be screened over short enough distances to allow for monitoring of discrete migration pathways.

- Where light nonaqueous-phase liquids (LNAPL), or contamination in the upper portion of a hydraulic unit, are being monitored, the screen should be set so that the upper portion of the water-bearing zone is below the top of the screen.

- Where dense nonaqueous-phase liquids (DNAPL) are being monitored, the screen should be set within the lower portion of the water-bearing zone, just above a relatively impermeable lithologic unit.

- The screened interval should not extend across an aquiclude or aquitard.

- If contamination is known to be present and concentrated within a portion of a saturated zone, the screen should be constructed in a manner that minimizes the potential for cross-contamination within the aquifer.

- If downhole geophysical surveys are to be conducted, the casing and screen material must be of sufficient diameter and constructed of the appropriate material to allow effective use of the geophysical survey tools.

- If aquifer tests are to be conducted in a monitoring well, the slot size must allow sufficient flux to produce the required drawdown and recovery. The diameter of the well must be sufficient to house the pump and monitoring equipment and to allow sufficient water flux (in combination with the screen slot size) to produce the required drawdown or recovery.

In many instances, it may be necessary to isolate stratigraphically higher portions of the subsurface, during drilling, from the zone being monitored. In these cases, special types of drilling may be necessary. An example of this is the use of temporary or permanent borehole casing that is telescoped to smaller diameters with depth. With this approach, a large diameter casing is installed through the zone to be isolated and drilling is continued to depth through this casing. If necessary, additional smaller diameter casing can be installed to stabilize the formation or isolate progressively deeper stratigraphic units. Another alternative involves the drilling of a large diameter borehole to the base of the zone to be isolated. This borehole is then sealed with a cement-bentonite grout. When the grout has cured, the well installation borehole is drilled through the grout down to its final completion depth. Just as with the casing approach described above, progressively deeper units can be isolated by the grouting of the portion of the borehole, which penetrates, then advancing the borehole through the hardened grout.

Before installing the casing and screen, they should be fitted with centralizers to assure a uniform thickness of the annular seals. The annular seal is composed of the filter pack, sand collar, bentonite seal, and cement-bentonite grout. The annular seal should have a uniform thickness around the casing and screen of between 2 to 4 inches. Thinner seals increase the possibility that the well screen may be exposed to the formation, and thicker seals may interfere with aquifer hydraulics around the screen. The selection of the centralizer material should be based on the same criteria used to select the casing and screen material. The centralizers should be spaced at closer intervals for smaller diameter casing and screen. Two-inch casing and screen should have centralizers installed approximately every 20 feet.

2.2 FILTER PACK

The filter pack will be composed of chemically inert, uncontaminated material. The preferred filter pack material is pure silica sand.

Methods for choosing filter pack grain size should be clearly outlined in the project-specific field sampling plan. Filter pack material must be tailored to the formation material. One method for choosing the filter pack grain size is based on the method proposed by NWWA (Aller 1989). Using this method, at least one standard sieve analysis of formation material is obtained. The grain size that retains 70 percent of the material is noted. This grain size is multiplied by a factor of 4 or 6. The factor of 4 is used for coarse-grained, poorly sorted formations, and the factor of 6 is used for fine-grained, well-sorted formations. The resultant grain size is used as the 70 percent retained point for the grain size of the filter pack. A second more conservative approach is described by Driscoll (1986). In this approach, the filter pack size is based on multiplying the 50 percent retained formation grain size by 2. If formation particle-size distribution information is not available, an Ottawa grade sand, American Society for Testing and Materials (ASTM) C-778 sand, or equivalent can be considered for use. The use of a default-size filter pack becomes more tenuous in increasingly finer-grained formations. The uniformity coefficient of the filter pack should not exceed 2.5. The filter pack should have a finished uniform thickness of 2 to 4 inches.

The filter pack should extend 2 feet above the top of the well screen. A sand collar should be installed on top of the filter pack. The sand collar should be constructed from fine silica sand (0.0021- to 0.0041-inch diameter) and extend 2 feet above the filter pack. This sand collar is intended to prevent intrusion of bentonite and grout into the filter pack.

2.3 GROUT AND CEMENT

Bentonite slurry should be placed in the annular pack for a minimum of 2 feet above the fine sand collar. This slurry should be mixed at a ratio of approximately 22 pounds of dry bentonite to 7 gallons of water. This should result in 10- to 11-pound per gallon slurry. The bentonite slurry will act as a formation seal for the monitoring well borehole. Cement and bentonite grout slurry will be placed in the annular space above the bentonite slurry, generally to a point about 2 feet below ground surface. Sufficient time should be allowed for the bentonite slurry to gel to a strength able to support the cement and bentonite grout. When mixing the bentonite slurry with a low shear device such as the grout pump or a drill rig, 30 to 60 minutes of mixing should be conducted prior to placing the slurry into the well annulus. After 30 to 60 minutes of low shear mixing, the slurry should be thick enough to support the cement-bentonite grout. The cement and bentonite grout will consist of mixture of 8 gallons of water, 5 pounds of bentonite powder (approximately 5 percent of the mix), and a 94-pound sack of Portland cement. An alternative cement-bentonite grout would be a premixed commercially equivalent material. A cement surface seal will be placed at the surface. Specific construction criteria may vary. These should be detailed in the project-specific FSP.

Bentonite slurry used as a formation seal above the filter pack and sand collar can be replaced with a seal composed of bentonite pellets or chips. These materials should be added to the annulus slowly to prevent bridging. Lifts of 3 to 4 inches should be separated by sufficient time to allow settlement. Past experience has shown that natural bentonite chips have slower hydration characteristics and are not as prone to bridging as formed bentonite pellets.

Bentonite seals are not always appropriate. If they are installed in the vadose zone, they may never fully hydrate, or they can dry, creating desiccation cracks. Both situations cause seal failure. Groundwater with high chloride concentrations or total dissolved solids greater than 500 parts per million (ppm) may inhibit the full hydration of the bentonite. This could limit the effectiveness of the annular seal. The case of bentonite in areas were the seal may be exposed to high concentrations of organic solvents, hydrocarbons, organic acids, basic and natural polar-organic compounds, and neutral nonpolar organic compounds may result in a several order-of-magnitude increase in the permeability of the seal. Neat cement is an alternative to bentonite seals given any of the above environmental conditions. Neat cement is a mixture of Portland cement (ASTM C-150) and water in the ratio of 5 to 6 gallons of water to 94 pounds of cement. Type I Portland cement is the most commonly used material for this application.

2.4 OTHER COMPONENTS

The procedures below should be followed under specific circumstances. Several other well components, which may be necessary depending of project specifications, are listed below:

- **Locking Well Caps and Outer Protective Casings.** These will be placed on all completed wells. These can be either aboveground or flush mount.
- **Bumper Posts or Well Head Protection.** Protective bumper posts or other types of protective barriers should be placed around each well with an aboveground completion.
- **Telescoping or Conductor Casing.** Telescoping or conductor casing is used when wells are drilled to fairly deep depths when drilling proceeds through several separate saturated intervals, or when drilling through grossly contaminated intervals.

3.0 OTHER TYPES OF WELLS

This section discusses other types of wells that may be installed in special cases. These include well points, wells installed through multiple saturated zones, well nests, and bedrock wells.

3.1 WELL POINTS

Under certain conditions, it may be necessary to install well points. These wells are driven directly into the subsurface by sledgehammer, power impact driver, or direct push methods such as Geoprobe® or cone penetrometer testing methods. Applications include use as vadose zone monitoring or shallow piezometer wells. However, the geologic subsurface must be compatible with this method. The utility of this method is limited because the annular space is generally not sealed to the surface. These types of wells are not currently a widely accepted alternative to permanent monitoring well installations and should only be used under special circumstances.

3.2 WELLS INSTALLED THROUGH MULTIPLE SATURATED ZONES

When wells are installed through multiple saturated zones, special well construction methods have to be used to ensure well integrity and to limit the potential for cross-contamination. Generally, these types of wells are necessary if hydraulic units are separated by relatively impermeable layers. Two procedures that may be used are described below.

The borehole is advanced to the base of the first saturated zone. Casing is then anchored in the impermeable layer below and grouted to the surface. After the grouting has cured, a smaller diameter borehole is drilled through the grout. This procedure is repeated until the zone of interest is reached. After this zone is reached, a conventional well screen and riser casing is set.

Another acceptable procedure involves driving a casing through several saturated layers, while drilling ahead of the casing. This method, however, is not acceptable when a competent aquitard or aquiclude may be structurally damaged by the driven casing, because this method may result in cross-contamination of two saturated layers.

3.3 WELL NESTS

Well nests are installed when several distinct intervals in an aquifer are to be sampled at each groundwater sampling location. These wells can be completed similarly to those described in Section 2.0. These wells can be installed in a single borehole or in close proximity to each other. When installing multiple wells in a single borehole, extreme care should be exercised when placing bentonite slurry seals above the filter packs. These seals must prevent flow between the wells in the single borehole.

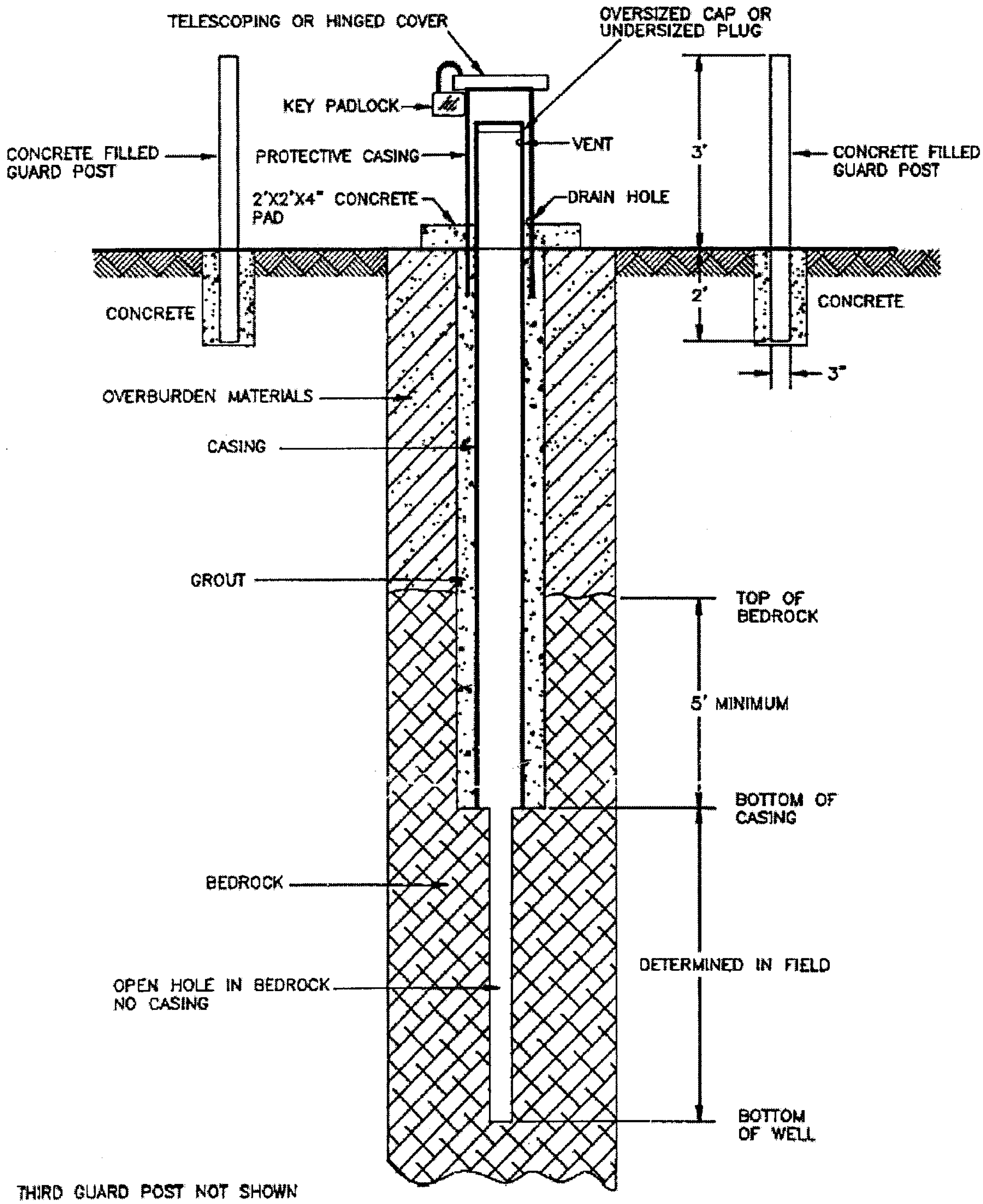
3.4 BEDROCK WELLS

Wells completed in bedrock will be drilled using the air or mud rotary method. Crystalline rock wells are usually drilled most efficiently with the air rotary method while consolidated sedimentary formations are drilled using either the air rotary or mud rotary method. The compressed air supply will be filtered prior to introduction into the borehole to remove oil or other contaminants. Bedrock wells may be completed as an open-hole, providing that borehole cave-in is not a possibility.

Bedrock wells will be advanced with air or mud rotary methods until a minimum of 5 feet of competent rock has been drilled. Minimum borehole diameter will be 8 inches. The drill string will then be pulled from the borehole and 6-inch I.D. Schedule 80 or 40 PVC casing inserted. Portland cement/bentonite grout will be pumped into the hole and up the annular space outside the casing. After the grout has set (minimum of 24 hours), the cement will be drilled out and the borehole advanced to the desired depth. Figure 2 shows typical construction details for an open-hole bedrock well. The preferred method of well completion for the bedrock wells will be open-hole. However, if the open borehole is subject to cave-in, the well(s) will be completed as screened and cased sand-packed wells.

FIGURE 2

TYPICAL BEDROCK WELL CONSTRUCTION



ATTACHMENT A

MONITORING WELL INSTALLATION RECORD

MONITORING WELL INSTALLATION RECORD

MONITORING WELL

MONITORING WELL NO.: ____________
PROJECT: ____________
SITE: ____________
BOREHOLE NO.: ____________
WELL PERMIT NO.: ____________
TOC TO BOTTOM OF WELL: ____________

DRILLING INFORMATION

DRILLING BEGAN:
DATE: ________ TIME: ________
WELL INSTALLATION BEGAN:
DATE: ________ TIME: ________
WELL INSTALLATION FINISHED:
DATE: ________ TIME: ________
DRILLING CO.: ____________
DRILLER: ____________
LICENSE: ____________
DRILL RIG: ____________
DRILLING METHOD:
- ☐ HOLLOW STEM AUGER
- ☐ AIR ROTARY
- ☐ OTHER: ____________

DIAMETER OF AUGERS:
ID: ________ OD: ________

WELL CASING

- ☐ SCHEDULE 40 PVC
- ☐ OTHER: ____________

PRODUCT: ____________
MFG. BY: ____________
CASING DIAMETER:
ID: ________ OD: ________
LENGTH OF CASING: ____________

WELL SCREEN

- ☐ SCHEDULE 40 PVC
- ☐ OTHER: ____________

PRODUCT: ____________
MFG. BY: ____________
CASING DIAMETER:
ID: ________ OD: ________
SLOT SIZE: ____________
LENGTH OF SCREEN: ____________

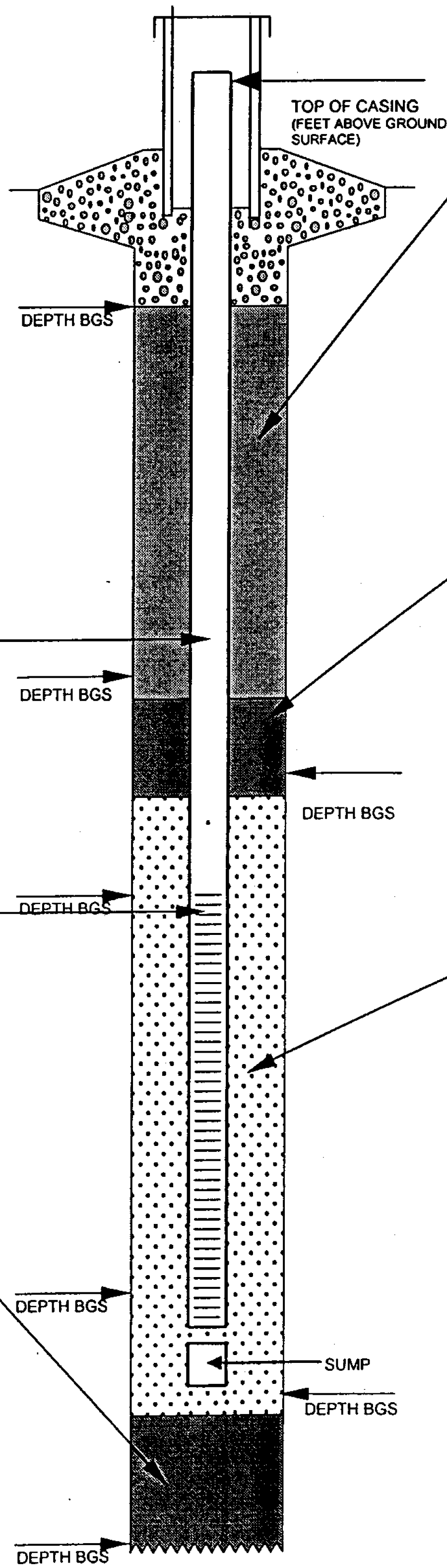
BOREHOLE BACKFILL

AMOUNT CALCULATED: ____________
AMOUNT USED: ____________
- ☐ BENTONITE CHIPS, SIZE: ____________
- ☐ BENTONITE PELLETS, SIZE: ____________
- ☐ SLURRY: ____________
- ☐ FORMATION COLLAPSE: ____________
- ☐ OTHER: ____________

PRODUCT: ____________
MFG. BY: ____________
METHOD INSTALLED:
☐ POURED ☐ TREMIE
☐ OTHER: ____________

SURFACE COMPLETION

- ☐ FLUSH MOUNT
- ☐ ABOVE GROUND WITH BUMPER POST
- ☐ CONCRETE ☐ ASPHALT



SURVEY INFORMATION

TOC ELEVATION: ____________
GROUND SURFACE ELEVATION: ____________
NORTHING: ____________
EASTING: ____________
DATE SURVEYED: ____________
SURVEY CO.: ____________

ANNULAR SEAL

VOLUME CALCULATED: ____________
AMOUNT USED: ____________
☐ GROUT FORMULA (PERCENTAGES)
PORTLAND CEMENT: ____________
BENTONITE: ____________
WATER: ____________
☐ PREPARED MIX
PRODUCT: ____________
MFG. BY: ____________
METHOD INSTALLED:
☐ POURED ☐ TREMIE
☐ OTHER: ____________

BENTONITE SEAL

VOLUME CALCULATED: ____________
AMOUNT USED: ____________
- ☐ PELLETS, SIZE: ____________
- ☐ CHIPS, SIZE: ____________
- ☐ OTHER: ____________

PRODUCT: ____________
MFG. BY: ____________
METHOD INSTALLED:
☐ POURED ☐ TREMIE
☐ OTHER: ____________
AMOUNT OF WATER USED: ____________

FILTER PACK

☐ PREPACKED FILTER
VOLUME CALCULATED: ____________
AMOUNT USED: ____________
☐ SAND, SIZE: ____________
PRODUCT: ____________
MFG. BY: ____________
METHOD INSTALLED:
☐ POURED ☐ TREMIE
☐ OTHER: ____________
WATER LEVEL: ____________
(BTOC AFTER WELL INSTALLATION)

CENTRALIZERS USED?

☐ YES ☐ NO;
CENTRALIZER DEPTHS: ________ ________

LEGEND
BGS = BELOW GROUND SURFACE
BTOC = BELOW TOP OF CASING
N/A = NOT APPLICABLE
NR = NOT RECORDED
TOC = TOP OF CASING

SOP APPROVAL FORM

THE PRESIDIO TRUST

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

MONITORING WELL DEVELOPMENT

SOP NO. 005

REVISION NO. 00

Last Reviewed: December 2000

Quality Assurance Approved

12 JAN 01

Date

1.0 BACKGROUND

Well development should be conducted as an integral step of monitoring well installation to remove the finer-grained material, typically clay and silt, from the geologic formation near the well screen and filter pack. Monitoring well installation is discussed in standard operating procedure (SOP) No. 004. Well development improves the hydraulic connection between water in the well and water in the formation. The fine-grained particles may interfere with water quality analyses and alter the hydraulic characteristic of the filter pack and hydrologic unit adjacent to the well screen.

All drilling methods impair the ability of an aquifer to transmit water to a drilled hole. Typically, this impairment is a result of disturbance of soil grains (smearing) or the invasion of drilling fluids or solids into the aquifer during the drilling process. Nonetheless, the impact to the hydrologic unit surrounding the borehole must be remediated if the well hydraulics and sampling of the monitoring well are to be representative of the aquifer.

1.1 PURPOSE

This SOP establishes the requirements and procedures for monitoring well development.

Well development improves the hydraulic characteristics of the filter pack and borehole wall by performing the following functions:

- Reduce the compaction and the intermixing of grain sizes produced during drilling by removing fine material from the pore spaces.
- Remove the filter cake or drilling fluid film that coats the borehole, and remove much or all of the drilling fluid and natural formation solids that have invaded the formation.
- Create a graded zone of sediment around the screen, thereby stabilizing the formation so that the well can yield sediment-free water.

1.2 SCOPE

This SOP applies to the specifications and methodologies of monitoring well development.

1.3 DEFINITIONS

Aquifer: A geologic formation, group of formations, or part of a formation that is saturated, and is capable of storing and transmitting water.

Bailer: A cylindrical sampling device with valves on either end used to extract water from a well. Bailers are usually constructed of an inert material such as stainless steel or polytetrafluoroethylene (Teflon®). The bailer is lowered and raised by means of a cable that may be cleaned and reused or by disposable rope.

Conductance (Specific): A measure of the ability of water to conduct an electric current. It is related to the total concentration of ionizable solids in the water. It is inversely proportional to electrical resistance.

Drilling Fluid: A fluid (liquid or gas) that may be used in drilling operations to remove cuttings from the borehole, to clean and cool the drill bit, and to maintain the integrity of the borehole during drilling.

Hydraulic Conductivity (k): The volume of water that will move in unit time under unit gradient through a unit area measured at right angles to the direction of flow.

Hydrologic Units: Geologic strata that can be distinguished based on the capacity to yield and transmit fluids. Aquifers and confining units are types of hydrologic units. Boundaries of a hydrologic unit may not necessarily correspond with laterally or vertically to lithostratigraphic formations.

Oil Air Filter: A filter or series of filters placed in the air-flow line from an air compressor to reduce the oil content of the air.

Oil Trap: A device used to remove oil from the compressed air discharged from an air compressor.

Riser: The pipe extending from the well screen to or above the ground surface.

Static Water Level: The elevation of the top of a column of water in a monitoring well or piezometer that is not influenced by pumping or conditions related to well installation, hydrologic testing, or nearby pumpage.

Transmissivity (T): The rate at which water is transmitted through a unit width of the aquifer under a unit hydraulic gradient. (Note: It is equal to an integration of the hydraulic conductivities across the saturated part of the aquifer perpendicular to the flow paths.)

Well Screen: A filtering device used to retain the annular filter pack materials; usually a cylindrical pipe with openings if a uniform width, orientation, and spacing.

Well Screen Jetting (Hydraulic Jetting): A means of well development, whereby a jetting tool comprising a perforated pipe connected to a high pressure pump, water is forced outwardly through the screen under pressure into the filter pack, and sometimes into the adjacent geologic unit.

1.4 REFERENCES

Aller, L. 1989. *Handbook of Suggested Practices for the Design and Installation of Groundwater Monitoring Wells.* National Well Water Association.

American Society for Testing and Materials (ASTM). 1989. "Proposed Recommended Practice for Design and Installation of Groundwater Monitoring Wells in Aquifers." *Annual Book of ASTM Standards.* Philadelphia, Pennsylvania.

California Environmental Protection Agency. 1995. "Monitoring Well Design and Construction for Hydrogeologic Characterization." *Guidance for Groundwater Investigations.* July.

Driscoll, F.G. 1986. *Groundwater and Wells.* Second Edition. Johnson Division, UOP, Inc. St. Paul, Minnesota.

1.5 REQUIREMENTS AND RESOURCES

There are various options available to develop monitoring wells. The procedures and equipment required are outlined in the following sections.

2.0 PROCEDURES

Methods of well development vary with the physical characterization of hydrologic units in which the monitoring well is screened and with the drilling method used. The most common methods of well development include mechanical surging, pumping or overpumping, airlift pumping, backwashing, and jetting. These methods may be effective alone or may need to be combined (for example, mechanical surging and overpumping). Factors such as well design and hydrogeologic conditions will determine

which well development method will be the most practical and cost effective. The most common and effective methods of well development are described in Sections 2.1 to 2.2.

A well development datasheet (Attachment A) can be used to document site-specific data.

2.1 MECHANICAL SURGING

The mechanical surging method forces water to flow in and out of the well screen by operating a plunger (or surge block) or bailer in the casing, similar to a piston in a cylinder. The surge block is typically attached to a drill rod or drill stem and is of sufficient weight to cause the block to drop rapidly on the down stroke, forcing water contained in the borehole into the aquifer surrounding the well. In the recovery stroke or upstroke, water is lifted by the surge block, allowing the flow of water and fine sediments back into the well from the aquifer.

The surge block should be lowered into the well to 10 to 15 feet beneath the static water level and above the well screen, depending on the hydrologic conditions of the aquifer. The water column will effectively transmit the action of the block to the filter pack and hydrologic unit adjacent to the well screen. The initial surging action should be relatively gentle, allowing any material blocking the screen to break up, go into suspension, and then move into the well. As water begins to move easily both in and out of the screen, the surging tool is usually lowered in increments to a level just above the screen. As the block is lowered, the force of the surging movement should be increased. In wells equipped with long screens, it may be more effective to operate the surge block in the screen to concentrate its actions at various levels. Development should begin above the screen and move progressively downward to prevent the tool from becoming sand locked in the well. Periodically a pump or bailer should then be used to remove dislodged sediment that may have accumulated at the bottom of the well during the surging process.

Surging can disturb the formation and or filter pack, altering the hydraulic properties of these units. In formations with high clay and silt contents, surging can cause the screen to become clogged with fines. In all applications, surging should be used with caution to prevent casing and screen damage.

2.2 OVERPUMPING

Overpumping involves pumping the well at a rate substantially higher than it will be pumped during well purging and groundwater sampling. This method is most effective on coarse-grained formations. Overpumping is commonly implemented by using a submersible pump. In cases where the water table is less than 30 feet from the top of the casing, it is possible to overpump the well with a centrifugal pump. The intake pipe is lowered into the top of the water table and water is extracted.

Withdrawal of water from the top of the water table results in the same inflow at the screen as is achieved with a submersible pump. Either method of overpumping will induce a high velocity water flow, resulting in the flow of sand, silt, and clay into the well; clogged opening screen slots; and cleaning formation voids and fractures. The movement of these particles at high flow rates should eliminate particle movement at the lower flow rates used during well purging and sampling. The bridging of particles against the screen, because of the flow rate and direction created by overpumping, may be overcome by using mechanical surging or backwashing in conjunction with this method.

Effective overpumping involves the discharge of large amounts of groundwater. This may be a problem where groundwater extracted during well development is contaminated with hazardous constituents.

3.0 OVERALL CONSIDERATIONS

Other methods of well development are also available. For small-diameter and small-volume wells, a bailer can be used in place of a submersible pump in the overpumping method. Similarly, a bailer can be used in much the same fashion as a surge block in small-diameter wells. Wells can be backwashed by simply adding water to agitate and remove fines plugging the screen and formation.

3.1 INITIATION OF WELL DEVELOPMENT

Regardless of the well development method selected, a few considerations, which are universally applicable, should be considered. First, well development should not be initiated within 48 hours of grouting, and should be completed within 1 week of drilling. As flow is established through the intake portion of the well, the degree of agitation can be slowly increased. Second, there should be no time limit placed on well development. Well development should be considered complete when the flow is reasonably clear and free of sediment and when pH, temperature, and specific conductivity have

stabilized. This threshold should be rechecked at least once after letting the well sit undisturbed until it has achieved 95 percent water elevation recovery. These considerations are described in detail in the "Proposed Recommended Practice for Design and Installation of Groundwater Monitoring Wells in Aquifers" (ASTM 1989).

3.2 WELL DEVELOPMENT FACTORS TO BE CONSIDERED

An important factor in any method is that the development work be started slowly and gently and that it be increased in vigor as the well is developed. Most methods of well development require the application of sufficient energy to disturb the filter pack, thereby freeing the fines and allowing them to be drawn into the well. The coarser fractions then settle around and stabilize the screen.

Development procedures for wells completed in fine sand and silt strata should involve methods that are relatively gentle, so that the strata material will not be incorporated into the filter pack. Vigorous surging for development can produce mixing of the fine strata and filter pack and produce turbid samples from the installation. In addition, development methods should be carefully selected based on the potential contaminant present, quality of wastewater generated, and requirements for containerization or treatment of wastewater.

For small-diameter and small-volume wells, a bailer can be used in place of a submersible pump in the pumping method. Similarly, a bailer can be used in small-diameter wells in much the same fashion as a surge block.

Wells can be backwashed by simply adding water to agitate and remove fines plugging the screen and formation.

Any time an air compressor is used, it should be equipped with an oil-air filter or an oil trap to minimize the introduction of oil into the screen area. The presence of oil would impact organic constituent concentrations of the water samples.

3.3 DURATION OF WELL DEVELOPMENT

Well development should begin after the monitoring well is completely installed and before water sampling begins. Development should be continued until representative water, free of the drilling fluids, cuttings, or other materials introduced during well construction, is obtained. Representative water is

assumed to have been obtained when pH, temperature, and specific conductivity readings stabilize and the water is visually clear of suspended solids. The minimum duration of well development should vary in accordance with the method used to develop the well. For example, surging and pumping the well may provide a stable, sediment free sample in a matter of minutes; whereas, bailing the well may require several hours of continuous effort to obtain a clear sample. Once the well is initially considered developed, it should be left to recover to at least 95 percent of its natural water elevation. Once this is achieved, the development procedure should be restarted and, if the physical chemical parameters used to determine well development have not changed, the well can be considered developed.

ATTACHMENT A

WELL DEVELOPMENT DATA SHEET

THE PRESIDIO TRUST

Sheet ___ of ___

WELL DEVELOPMENT DATA SHEET

BORING NO. ___________ **WELL NO.** ___________

Project/Site Name ______________________
Trust MWO No. ______________________
Date(s) of Installation ______________________
Date(s) of Development ______________________
Personnel/Company ______________________

____

Type of Rig Used ______________________

Casing Diameter/Type ______________________
Borehole Diameter ______________________
Screened Interval(s) ______________________
Total Length of Well Casing ______________________
Measured Total Depth (TOC) Initial ______________
Final ______________
Initial Depth to Water
(TOC) ____________ Date ________ Time ________
Stabilized Depth to Water
(TOC) ____________ Date ________ Time ________

TECHNIQUE(S) — DEVELOPMENT EQUIPMENT TYPE/CAPACITY

___ Jetting (Airlift) ______________________
___ Surge Block ______________________
___ Bailing ______________________
___ Pumping ______________________
___ Other ______________________

FLUIDS ADDED

Lost Drilling Fluid: ____________ Gallons
Lost Purge Water: ____________ Gallons
Water During Installation: ____________ Gallons
Total Fluids Added: ____________ Gallons
Source of Added Water: ______________________
Sample Collected of Added Water: Y N
Sample Designation of Added Water: ______________________

PURGE VOLUME CALCULATION

Casing Volume: ____________ Ft. of water
x ____________ Gallons/Foot
= ____________ Gallons per Single Casing Volume
Sand Pack Volume: ________ Ft. of Saturated Sand Pack
x ____________ Gallons/Foot (borehole diameter)
= ____________ Gallons (in borehole)
- ____________ Gallons of Casing Volume
= ____________ x 0.3 (Assuming porosity = 30%)
= ____________ Gallons Within Sand Pack
Single Purge Volume: ____________ Gallons (Casing Vol. + Sand Pack Vol. + Fluids Added)
Minimum Purge Volume: ____________ Gallons
Actual Purge Volume: ____________ Gallons
Volume Measured by: ______________________
Rate of Development ________ Gallons/Minute (Hour, Day)
Pumping Rate/Depth ____________ @ ______ Ft. (Below Grd.)
Immiscible Phases Present: Y N Thickness ____________

Development Criteria: ______________________

Total Volume Discharged	Rate of Discharge	Time	Temp	pH	Specific* Conductance	Turbidity (NTU)	D.O., Clarity, Odor, PID Readings, Other

Development Completed at ____________ Gallons Discharged. Date: ________ Time: ____________

Personnel: ______________________

* Specific Conductance readings temperature compensated to 25°C, if not, report temperatures at which reading obtained.

APPENDIX C

EXAMPLE FIELD FORMS

FIELD LOG OF BORING
CHAIN OF CUSTODY FORM
CONFIRMATION SAMPLE ANALYTICAL RESULTS
DAILY FIELD LOG
PHOTOGRAPHIC REPORTING DATA SHEETS
MONITORING WELL INSPECTION FORM
MONITORING WELL SAMPLING LOG
GROUNDWATER LEVEL MEASUREMENTS LOG

REVIEWED BY: SJK

FIELD LOG OF BORING

SHEET ____ OF ____

LOCATION OF BORING:	PROJECT:
	BORING NO.
	TOTAL DEPTH:
	JOB NO.:
	LOGGED BY:
	PROJ. MGR.:
	EDITED BY:
	DRILLING CONTRACTOR:
	DRILL RIG TYPE:
	DRILLERS NAME:
	SAMPLING METHODS:
	HAMMER WT.:
	DROP:
	STARTED, TIME:
	DATE:
	COMPLETED, TIME:
	DATE:

BORING DEPTH (ft.)			
CASING DEPTH (ft.)			
WATER DEPTH (ft.)			
TIME:			
DATE:			

BACKFILLED, TIME: DATE: BY:

SURFACE ELEV.: DATUM:

CONDITIONS:

SAMPLE DEPTH	SAMPLER TYPE	BLOWS/6-IN.	INCHES DRIVEN	INCHES RECOVERED	SAMPLE CONDITION	DRILLING RATE (min/ft)				DEPTH IN FEET	GRAPHIC LOG
										1	
										2	
										3	
										4	
										5	
										6	
										7	
										8	
										9	
										10	

FF7

MACTEC

FIELD LOG OF BORING (CONTINUED) SHEET ____ OF ____

PROJECT:	NO.	BORING NO.

DEPTH	TYPE	BLOWS	DRIVEN	REC'V'D.	COND.	D.RATE				DEPTH	GRAPHIC LOG	
										1		
										2		
										3		
										4		
										5		
										6		
										7		
										8		
										9		
										0		
										1		
										2		
										3		
										4		
										5		
										6		
										7		
										8		
										9		
										0		

FF8

MACTEC

MACTEC
5341 Old Redwood Highway
Suite 300
Petaluma, CA 94954
(707) 793-3800

CHAIN OF CUSTODY FORM

Seq. No.: № 1267

Samplers: ______

Lab: ______

Job Number: ______

Name/Location: ______

Project Manager: ______ Recorder: ______ (Signature Required)

MATRIX				# CONTAINERS & PRESERV.						SAMPLE NUMBER		DATE				STATION DESCRIPTION		ANALYSIS REQUESTED
Water	Soil	Air		Unpres.	H2SO4	HNO3	HCL			YR	SEQ	YR	MO	DAY	TIME		DEPTH	

ADDITIONAL INFORMATION

SAMPLE NUMBER		TURNAROUND TIME/ REMARKS
YR	SEQ	

CHAIN OF CUSTODY RECORD

Relinquished By *(Signature)*	*(Print Name)*	*(Company)*	Date/Time
Received By *(Signature)*	*(Print Name)*	*(Company)*	Date/Time
Relinquished By *(Signature)*	*(Print Name)*	*(Company)*	Date/Time
Received By *(Signature)*	*(Print Name)*	*(Company)*	Date/Time
Relinquished By *(Signature)*	*(Print Name)*	*(Company)*	Date/Time
Received By *(Signature)*	*(Print Name)*	*(Company)*	Date/Time

Method of Shipment:

Confirmation Sample Analytical Results
Building 1065 Corrective Action Implementation
Date, 2007
Presidio of San Francisco, California

Station Name	Sample Number	Sample Date	Sample Results (milligrams per kilogram)										
			Analyte & Test Method	TPH Gasoline (C7-C12) 8015 Modified	TPH Diesel (C12-C24) 8015 Modified	TPH Fuel Oil (C24-C36) 8015 Modified	VOCs 8260*		PAHs 8270SIM*	Metals 6010/6020/7471*			
							Benzene	2-Hexanone		Arsenic	Cadmium	Lead	Zinc
			Cleanup Level	100	115	160	0.005	2.7	varies*	5.9	1.7	400	22,000
1065EX300	1065EX300( )	7/10/2007											
1065EX301	1065EX301( )	7/10/2007											
1065EX302	1065EX302( )	7/10/2007											
1065EX303	1065EX303( )	7/10/2007											
1065EX304	1065EX304( )	7/10/2007											
1065EX305	1065EX305( )	7/10/2007											
1065EX306	1065EX306( )	7/10/2007											
1065EX307	1065EX307( )	7/10/2007											
1065EX308	1065EX308( )	7/10/2007											
1065EX309	1065EX309( )	7/10/2007											
1065EX309	DUP071007	7/10/2007											

TPH Total petroleum hydrocarbons.
VOCs Volatile organic compounds.
PAHs Polycyclic aromatic hydrocarbons.
* Specific analytes and cleanup levels for VOCs, PAHs, and Metals will be listed on this table if they are detected above the laboratory reporting limit.

Daily Field Log

Sheet ______ of ______

Project Name: Building 1065 Area CAP Implementation **Job #** ______________ **Task:** ________

Date: ______________________________

Project Location: ______________________________

Notes by: ______________________________

Onsite Personnel: ______________________________

Site Visitors: ______________________________

Weather: ______________________________

Site Conditions & Safety Considerations: ______________________________

Monitoring Equipment Used: **Calibration** **Date**

Number of samples collected: Soil:________ Water:________			**COCs Attached**	**Yes**	**No**
			Sample Location Map Attached	**Yes**	**No**

Time Collected	**Sample ID**	**Depth**	**Notes**

Contractor Equipment Onsite:

Estimated volume excavated	**Site Plan Attached**	**Yes**	**No**
Truck Loads of Soil Off-Hauled	**Manifests/Bills of Lading Attached**	**Yes**	**No**
Imported Backfill Truckloads or Cubic Yards	**Bills of Lading Attached**	**Yes**	**No**

Daily Field Logs

Sheet ________ of ________

Project Name:	Building 1065 Area CAP Implementation	**Job #**	**Task:**
Date:			
Notes by:			

Materials onsite

Field Notes:

Photographic Reporting Data Sheets

Job # ______________________________

Photographer Name: ______________________________

Picure ID	Time Taken	Location	Picture Description (including subject, picture orientation [which direction you were facing when taking the picture], distance to subject, and scale of subject)

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MONITORING WELL INSPECTION FORM

Monitoring Well No.:______________ **Date:**______________

Detail the condition of the items identified below, as applicable to each individual well

External well identification:

Internal well identification:

Concrete pad and surrounding area:

Well vault or stickup:

Well lid (if applicable):

Rubber seal (if applicable):

Lid bolts (if applicable):

Well cap:

Well lock:

Water level measuring mark and/or notch:

Was there standing water in the well vault/well stickup? Yes_____ No_____

Note any abnormalities regarding the well vault in relation to the surrounding grade:

MONITORING WELL INSPECTION FORM
(CONTINUED)

If necessary, using the following space, note any discrepancies between the well location portrayed on the well location map and the location of the well as identified in the field.

Location sketch:

Identify all light maintenance completed during well inspection:

Additional Comments:

Prepared by:____________________________

Monitoring Well Sa ng Log (Low Flow)

MWO#: ______ **Project/Site Name:** ______ **Date:** ______ **Well ID:** ______

Well Data:

Casing Diameter: ______
Borehole Diameter: ______
Depth of Casing (ft bTOC): ______
Screen Interval (ft bTOC): ______
Pump Intake (ft bTOC): ______
Well Condition (Comments): ______

Weather (temp/pressure/wind): ______

Initial Measurements & Calculations:

Initial PID Reading at TOC (ppm): ______
Depth to Product (ft bTOC; NA if none): ______
Product Thickness (ft bTOC): ______
Static Depth to Water (ft bTOC): ______
Standing Water Column (ft): ______
a) One Pump Volume (mL): 300 mL
b) One Tube Volume (mL): ft x (9.7 ml/ft)= mL
c) One Purge Volume (=a+b): mL
Minimum Volume to be Purged (=2xc): mL

Equipment Documentation:

Water Level Meter: ______
Product Probe/Sampler (NA if none): ______
Multi-Parameter Meter: ______
PID: ______
Purge/Sample Pumps: ______
Control Box Settings:
Pressure (psi): ______
Fill Cycle (sec): ______
Pump Cycle (sec): ______

All measurements taken from the surveyor mark at top of casing, or north side if no mark exists.

Time	Amount Purged (mL)	Field Parameters Measured							PID	Depth to Water (ft bTOC)	Flow Rate (mL/min)	Comments (field observations, odor, color, problems, well performance, etc.)	Field Tech.
		Temp. (°C)	Salinity (%)	pH	S.C. (mS/cm)	Turbidity (NTU)	D.O. (mg/L)	ORP (mV)	Breathing Zone / TOC				
												(flow reduced to ____ ml/min prior to VOC collection)	
Sample													

Purge Information:

Purge Method (circle one): Marshalk System / Aquarious / Bladder Pump
Time Purging Began: ______
Total Milliliters Purged: ______
Total Pump/Tubing Volumes Purged: ______
Time Purging Completed: ______

Sampling Information:

Sampling QA/QC Requirements (circle one): NA Dup/Split MS/MSD
Sampling Method: ______
Time Sampling Began: ______
Filter Type (size/brand): NA / QEC (0.45 micron) / Other:
Amount Flushed Through Filter (well water in mL): ______
Time Sampling Completed: ______

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GROUNDWATER LEVEL MEASUREMENTS LOG

Circle type of organic vapor meter used: PID FID

Well Number	PID/FID Reading (ppm)	Time	Depth to Groundwater (ft.) (three measurements)			Depth to Bottom (ft.)	Comments
			1st	2nd	3rd		

Date: ____________

Field Staff: ____________ Field Staff Signature: ____________

Page No.: ____________

APPENDIX D

APPLICATION OF OXYGEN RELEASING PRODUCT IN EXCAVATIONS

REVIEWED BY: SU

CONTENTS

TABLES

FIGURE

ATTACHMENTS

APPENDIX D
APPLICATION OF OXYGEN RELEASING PRODUCT IN EXCAVATIONS

Oxygen releasing products may be applied within excavations to enhance aerobic biodegradation of petroleum hydrocarbon contaminants in: (1) saturated soils and/or groundwater within the smear zone, and (2) groundwater downgradient of the application area. This appendix summarizes the evaluation, assumptions, the basis for its use, and estimates the quantity of oxygen releasing product that may be applied within the excavations of Soil and Groundwater Remedial Units A (RUs-A) at the Building 1065 Corrective Action Plan (CAP) Site. This appendix also describes oxygen releasing product application and groundwater monitoring conducted at the Building 637 CAP Site at the Presidio (*EKI, 1999a, 1999b, 2000, 2004*). These data were evaluated to assess: (1) the site conditions, (2) assumptions and results of oxygen releasing product application at the Building 637 CAP Site, (3) groundwater monitoring results, and (4) "lessons learned" from use of oxygen releasing product at the Building 637 CAP Site.

D-1.0 SITE BACKGROUND AND PURPOSE

This section describes the background conditions at RUs-A where oxygen releasing product may be applied after source removal is accomplished, and the purpose of applying an oxygen releasing product.

D-1.1 Site Background

Soil beneath, north, and south of Building 1063 (Areas 1, 2, and 3, respectively) primarily contains the chemicals of concern (COCs) total petroleum hydrocarbons as fuel oil, gasoline and diesel (TPHfo, TPHg, and TPHd, respectively) and the volatile organic compounds (VOCs) benzene, ethylbenzene, 2-hexanone, and toluene at concentrations exceeding applicable cleanup levels within RUs-A. Soil in these areas also contain the polycyclic aromatic hydrocarbon (PAH) benzo(a)pyrene and metals at concentrations exceeding applicable cleanup levels within RUs-A. Groundwater monitoring and hydropunch data show that TPHg, benzene, and arsenic have been detected above cleanup levels in the shallow groundwater zone in the vicinity of Building 1063. The primary source of petroleum hydrocarbons detected in soil and groundwater at RUs-A is likely releases from former diesel and gasoline underground storage tanks (USTs) located south (upgradient) of Building 1063. Petroleum hydrocarbon-impacted soil south of RUs-A was excavated and disposed off-site as part of the 2003-2004 Phase I Interim Action (IA).

The Trust plans to excavate petroleum hydrocarbon-impacted soil from RUs-A until confirmation soil sampling results show that concentrations of COCs in soil are below cleanup levels. RUs-A comprise three separate excavation areas as listed below:

- <u>Area 1</u> – Located beneath the concrete foundation inside Building 1063;
- <u>Area 2</u> – Located just north of the Building 1063 foundation; and
- <u>Area 3</u> – Located just south of the Building 1063 foundation.

D-1.2 Purpose of Applying an Oxygen Releasing Product

Building 1063 is considered an historic structure of contributive value to the National Historic Landmark (NHL) and therefore, has been designated to be preserved. The building comprises a concrete slab floor, axial gable roof, roof support columns on 12-foot spacings, and walls composed of corrugated iron. In order to excavate soils from Area 1, portions of the existing concrete slab within the western portion of Building 1063 will be saw-cut and removed. Select building support columns will be removed, the integrity of the roof support will be maintained through shoring, and portions of the mezzanine located in the northern portion of Building 1063 may need to be removed to accommodate soil excavation. Excavation in Areas 2 and 3 will occur directly adjacent to the walls and footings of the Building 1063 foundation.

The purpose of applying an oxygen releasing product to the excavation bottoms in these areas is to remediate residual petroleum hydrocarbons: (1) left in place in saturated soils at RUs-A, and/or (2) present in groundwater. It is possible that due to structural constraints in the three excavation areas posed by the presence of the foundation, walls, or footings of Building 1063, soil removal may be impracticable for over-excavation. Accordingly, some petroleum hydrocarbon-impacted saturated soils may be left in place. An oxygen releasing product may be used to stimulate aerobic bioremediation of petroleum impacted soils and groundwater.

D-2.0 EVALUATION AND COMPARISON OF OXYGEN RELEASING PRODUCT APPLICATION AT BUILDING 637 CAP SITE AND BUILDING 1065 RUS-A

In 1999 and 2000, oxygen releasing product was applied to soil to treat residual petroleum hydrocarbon contamination in soil at the Building 637 CAP Site (*EKI, 1999a, 1999b, 2000, 2004)*. The site conditions and application quantities used at the Building 637 CAP Site were reviewed to provide supporting data to assist in the evaluation and development of the proposed application quantity of oxygen releasing product at RUs-A at the Building 1065 CAP Site. This evaluation and comparison is summarized below and is supported by data compiled in Table D-1 (Comparison of Oxygen Releasing Product Application at Building 1065 and Building 637 CAP Sites) and Table D-2 (Site-Specific Petroleum-Related Concentrations use to Estimate Average Soil and Groundwater Concentrations, Area 1).

D-2.1 Comparison of Site Conditions

The Building 637 and Building 1065 CAP Sites are similar in terms of (1) soil types consisting of fill underlain by silty sands and Bay Mud, (2) depth to groundwater, and (3) the type and distribution of petroleum contamination, as described below.

Soils at the Building 637 CAP Site consist of fill material and naturally occurring interbedded fine-grained estuarine and sand deposits. Fill material extends 8 to 9 feet below ground surface (bgs). Monitoring wells are installed in two distinct water bearing zones: A1 and A2. Groundwater is typically encountered from 3 to 9 feet bgs in the A1 zone and 4 to 7 feet bgs in the A2 zone.

Building 1063 is underlain by fill and native deposits consisting of clayey or silty sand, Bay Mud, and silt. The fill extends to depths of 3 to 7 feet. Shallow groundwater (A zone) consists of saturated portions of the fill and shallow sand. Depth to groundwater is about 8 feet bgs. Intermediate groundwater (B zone) is separated from shallow groundwater by the Bay Mud.

Soil and groundwater at both sites has been impacted by leaking petroleum fuel tanks and/or fuel distribution systems and share the following primary chemicals of concern: TPHg; TPH diesel (TPHd), TPH fuel oil (TPHfo), and benzene. The concentrations of TPHg in soil and groundwater are similar at both sites.

D-2.2 Evaluation of Oxygen Releasing Product and Application Quantities at Building 637 CAP Site

Petroleum-impacted soil was excavated by the Trust at six areas (Areas A, B, C, D, E, and F) at the Building 637 CAP Site (*EKI, 1999a, 1999b, 2000, 2004)*. Oxygen releasing product was applied to excavations at Areas C and F during backfilling and was applied via injection at an area located between two previous excavations conducted by the Army (referred to as the “area between the Army excavations”) (see Attachment, Extent of Excavations and ORC Treatment Area Maps).

The specific oxygen releasing product used at Building 637 CAP Site was Oxygen Release Compound (ORC) manufactured by Regenesis Technical Support (Regenesis). ORC is a magnesium peroxide based product. In contrast, ORC Advanced TM is proposed for use at RUs-A, which is a calcium peroxide based product. Regenesis modified and improved its oxygen releasing product since the Building 637 CAP Site work was conducted; therefore it is not possible to provide a direct comparison between ORC application quantities between these two sites.

At the Building 637 CAP Site, the estimated mass of hydrocarbons present in residual soil was determined for soil at Area F and the area between the Army excavations (*EKI, 1999b)*. Based on site-specific soil data and COC concentrations collected from the Building 637 CAP Site, the Trust's contractor, Erler and Kalinowski, Inc. (EKI), estimated 21,800 lbs of hydrocarbons (1,800 lbs TPHg in Area F and 20,000 TPHd in the area between the Army excavations) were present in the smear zone soils. Based on site-specific groundwater data from the Building 637 CAP Site (and multiplying by an additional demand factor of 7 to 10 as suggested by Regenesis), EKI estimated approximately 7 to 10 pounds of hydrocarbons were present in groundwater. However, due to the disparity in the mass estimates using soil and groundwater data, EKI used the ORC application quantity that Regenesis recommended. Approximately 1,320 lbs of ORC (0.3 percent ORC by weight of treated soil) was applied to the excavations at Areas C and F. Similarly, the quantity of ORC injected in the area between the Army excavations was based on Regenesis' recommendations. Approximately 2,690 lbs of ORC was applied via injection.

For the proposed corrective action at the RUs-A, Regenesis recommended ORC Advanced™ be applied at 0.4 percent ORC Advanced™ by weight of impacted soil. This recommendation is based on experience that Bay Mud generally exhibits a relatively high oxygen demand due to the high level of inorganic carbon and non-petroleum organic materials in the soil.

Although the sites are similar in terms of (1) soil types, (2) depth to groundwater, and (3) the type and distribution of petroleum contamination, Regenesis recommended more than twice as much oxygen by weight of soil at RUs-A (0.00068 pounds) compared to the recommendation they provided at the Building 637 CAP Site (0.0003 pounds), as follows:

- For every pound of soil treated at RUs-A, 0.004 pounds of ORC Advanced™ times 0.17 pounds of oxygen released by ORC Advanced™ yields about 0.00068 pounds of oxygen.

- For every pound of soil treated at the Building 637 CAP Site, 0.003 pounds of ORC times 0.1 pounds of oxygen released by ORC yields about 0.0003 pounds of oxygen.

The additional oxygen dosage recommended by Regenesis at RUs-A is to accommodate for the expected higher oxygen demand from organic materials present in the Bay Mud underlying the site. Based on Regenesis' experience in the several years since the ORC design was prepared for the Building 637 CAP Site, they now recommend more than twice the oxygen dosage to meet the high oxygen demand present in a Bay Mud environment such as is present within RU-A

D-2.3 Groundwater Monitoring

The results of groundwater monitoring at the Building 637 CAP Site indicated that source removal and ORC application was effective in reducing concentrations of petroleum-related COCs in groundwater at the site to levels below applicable cleanup levels. ORC was applied within the excavated areas prior to backfilling and via injection points in a separate area between excavations where soil was not excavated. Three monitoring wells located immediately downgradient of the ORC application area were monitored prior to the ORC injection to establish a baseline for evaluating the effectiveness of the source removal and ORC application. Baseline monitoring was performed four months after placement of the ORC in the excavation, and 20 days prior to injection. Quarterly sampling was conducted for two years after the ORC was applied. Based on groundwater monitoring results, concentrations of COCs in groundwater decreased or remained below cleanup levels (see Attachment, Groundwater Monitoring Results at Building 637 CAP Site).

Groundwater monitoring will be conducted at RUs-A prior to placement of the oxygen releasing product, within 14 days of oxygen releasing product application if it is applied, and quarterly thereafter. As summarized in Table 2-1 of the Work Plan, the new monitoring well that will be installed prior to excavation to replace 1065PZ1A, and existing monitoring wells 1065MW101A, and 1065MW102A will be monitored for water levels, TPHg, BTEX, arsenic, aluminum, iron, manganese, and the redox parameters dissolved oxygen and oxidation reduction potential, and field parameters for four quarters, then semiannually. In addition, the following wells will be monitored quarterly for one year then annually for water levels, arsenic, redox parameters, and field parameters: 1065PZ2A, 1065PZ3A, 1065PZ4A, 1065PZ5AR, 1065PZ6A, and 1065MW10A. This monitoring approach will allow for evaluation of the effectiveness of the ORC Advanced ™ in reducing contaminant concentrations in groundwater. Although Regenesis also includes a general recommendation in their *Letter Proposal* (see Attachment) to monitor groundwater for the additional parameters of biological oxygen demand (BOD) and chemical oxygen demand (COD), these data will not be collected because the monitoring parameters listed above will provide a comprehensive data set to design and monitor the effectiveness of oxygen releasing product application at RU-A as described in Section D-3.0.

D-2.4 Lessons Learned at Building 637 CAP Site

Oxygen releasing product at RUs-A may be applied to the excavations to reduce residual concentrations of petroleum-related COCs in saturated soils and groundwater. The following “lessons learned” at Building 637 were identified and used to develop the proposed oxygen releasing product design presented in Section D-3.0:

- The quantity of oxygen releasing product to be applied to soil excavations recommended by Regenesis can be effective at reducing petroleum-related contamination from residual concentrations of petroleum-related COCs in saturated soils and groundwater. Regenesis’ calculations are based on the estimated weight of soil impacted by petroleum hydrocarbons and the presence of Bay Mud, and do not specifically consider the concentrations of contaminants in the soil. The Bay Mud has a high oxygen demand compared to other types of soil.

- The theoretical mass of residual petroleum-related contamination in soil to be treated greatly over-estimates the quantity of oxygen releasing product needed to treat the soil. Regenesis’ experience in the Bay Area is an important consideration in determining oxygen releasing product quantity.

- Confirmation soil sampling data collected during the excavation should be used to adjust the oxygen releasing product quantity to be applied, if needed. The estimated oxygen releasing product quantity is based on site data before the soil is excavated. During excavation, the specific concentrations of COCs and distribution of COCs may allow for a reduction in the proposed amount of ORC Advanced ™ identified in Regenesis’ original estimate (see Attachment, Regenesis *Letter Proposal – Area 1*). The quantity of product to be applied should be reduced proportionally to the observed COC distribution.

- Although the effectiveness of ORC application at the Building 637 CAP Site can not be wholly assessed on its own merits because it was implemented in conjunction with source removal by excavation, and monitoring was performed four months following application of ORC in the excavation, the same combined approach (soil excavation and possible application of ORC Advanced™) is proposed at RUs-A, and is anticipated to be effective at reducing concentrations of COCs in soil and groundwater.

D-3.0 PROPOSED OXYGEN RELEASING PRODUCT APPLICATION FOR RUS-A EXCAVATIONS

ORC Advanced ™ is proposed for application within excavations at RUs-A at the quantity recommended by Regenesis in their *Letter Proposal*, dated January 25, 2007 (see Attachment). The proposed application design is labeled in the proposal as "preliminary" in order to allow for flexibility in adapting the design based on additional data that will be collected between the date of publication of this Work Plan, and the initiation of construction activities (excavation and source removal).

The proposed ORC Advanced ™ application quantity to be applied at the bottom of the excavations at RUs-A is based on the following site-specific data at RUs-A:

1) Weight of soil; and
2) Type of soil.

Regenesis based their recommended application quantity on the estimated weight of the soil and the type of soil in the saturated zone of the RUs-A for the Area 1 excavation. The evaluation was conducted for Area 1 because this area: (1) is the largest of the three excavation areas, (2) has the highest concentrations and deepest detections of petroleum-related COCs within the saturated zone, and (3) is considered the primary source area of petroleum-related contamination within RUs-A.

The ORC Advanced ™ quantity needed to enhance biodegradation of petroleum-related COCs in the excavation smear zone within RUs-A Area 1 is primarily based on the estimated weight of soil and the type of soil as follows:

- <u>Weight of soil:</u> The weight of soil is estimated by assuming an average soil density of 1.76 grams per cubic centimeter; or 110 pounds per cubic feet (lbs/ft^3) times the volume of residual soil occupied by petroleum hydrocarbons. Regenesis based their recommended application quantity in part on the above estimated" in place" weight or density of the soil within the RU-A excavation of approximately 110 pounds per cubic foot, which is approximately 1.485 tons per cubic yard. Based on data from the excavation and offsite disposal of petroleum hydrocarbon-impacted soil south of RUs-A conducted as part of the 2003-2004 Phase I Interim Action (IA), the average weight of excavated soil hauled offsite was approximately 1.8 tons per cubic yard (*MACTEC, 2004b*). The proposed ORC Advanced ™ application quantity is based on the weight of "in place" soils, because it will be applied in situ, and will not be subject to the same amount of expansion and increase in volume as the excavated IA soils; in addition, the type of soil is a predominant factor in selecting the application quantity, and therefore an increase in the assumed weight of soil to the higher excavated IA amount would not affect the proposed application quantity,

- <u>Recommended ORC Advanced™ quantity for RUs-A</u>: 0.4 percent ORC Advanced ™ by weight of impacted soil; the typical range of oxygen percentage recommended for backfill applications is 0.1 percent to 0.6 percent oxygen releasing product by weight of impacted soil;

- <u>Oxygen releasing product quantity per cubic foot of soil using ORC Advanced</u> ™:
    - 110 pounds (lbs)/cubic foot (ft^3) of soil x 0.004 (0.4 percent ORC Advanced ™) = 0.44 lbs of ORC Advanced ™ per ft^3 of soil.

- <u>Estimated number of cubic feet of petroleum-impacted soil potentially left in-place surrounding the excavation at Area 1:</u>
    - Estimated 15,000 ft^3 of impacted soil (assuming the dimensions of the excavation in Area 1 is 50 feet x 60 feet x 5 feet).
    - Estimated 28,800 ft^3 of saturated soil in the plume including the smear zone (assuming the dimensions of the area of petroleum-related groundwater impacts at RUs-A is 60 feet x 80 feet x 6 feet).
    - Estimated 13,800 ft^3 (28,800 ft^3 — 15,000 ft^3 = 13,800 ft^3) of petroleum-impacted saturated soil potentially left in-place in Area 1 after soil is excavated.
- <u>Amount of ORC Advanced™ recommended for residual soil</u>
    - 13,800 ft^3 x 0.44 lbs/ft^3 = approximately 6,000 lbs of ORC Advanced™.

The proposed quantity of ORC Advanced™ is the quantity that would need to be applied under "worst case" conditions (i.e., the residual COCs in saturated soil are the maximum concentration of COCs observed at the site). The actual quantity of ORC Advanced™ can be adjusted based on confirmation soil sample results. Excavation followed by confirmation soil sampling may indicate the excavation is clean (i.e., no COCs are detected above cleanup levels), or that low levels of residual petroleum contamination remain in the excavation.

Due to structural constraints in the excavation areas posed by the presence of the foundation, walls, or footings of Building 1063, soil may be left in place at concentrations exceeding cleanup levels. For example, the excavation inside Building 1063 may be implemented in increments where soil is strategically removed around the existing columns then backfilled before moving to the next excavation. In this case, if the confirmation soil samples indicate COCs are present, ORC Advanced™ may need to be applied to the excavation bottom before the excavation is backfilled. Another scenario where the quantity can be modified is if COCs are present in the saturated soils in Areas 2 and 3. It is currently not anticipated that petroleum-related COCs are present below the water table in these areas. The following application quantity is proposed to allow for these possible conditions:

- <u>Quantity of ORC Advanced™ recommended per square foot of excavation bottom in saturated soils within Areas 1, 2, and 3 assuming petroleum-related COCs are left in-place:</u>
    - 6,000 lbs/3,000 ft^2 = approximately 2 lbs of ORC Advanced™ /ft^2 of impacted soil.

D-4.0 COMMUNICATIONS

Based on recommendations presented in the Building 1065 CAP, oxygen releasing product may need to be applied to excavations to reduce the concentrations of petroleum-related COCs in saturated soils. Figure D-1 (Decision-Making and Communications Flow Chart for Oxygen Releasing Product Application in Excavations) outlines two possible scenarios that are anticipated and will be assessed to determine whether oxygen releasing product will be applied to the excavations:

Scenario 1—petroleum-related COCs are not detected in confirmation soil samples; and

Scenario 2—petroleum-related COCs are detected in confirmation soil samples.

Under the conditions presented in Scenario 1, oxygen releasing product will not be applied. Under the conditions presented in Scenario 2, ORC Advanced™ would be applied to the excavation at a quantity of 2 lbs of ORC Advanced™ per ft^2 of impacted soil. If the oxygen releasing product application dose is determined to require adjustment prior to application, the Trust will provide documentation of any modifications to the Regional Water Quality Control Board (Water Board), National Park Service (NPS) and other interested stakeholders as shown on Figure D-1. Communication would be facilitated with emails and/or faxes to streamline the process, as well as being documented in field records and weekly meetings.

The oxygen releasing product application method and quantity and groundwater monitoring results used to assess the effectiveness of the application will be presented in the Construction Completion Report; groundwater monitoring data will also be presented in the Trust's Semi-Annual Groundwater Monitoring reports, respectively as summarized in Section 7.0 of the Work Plan.

D-5.0 REFERENCES

Erler & Kalinowski, Inc. (EKI), 1999a. *Final Corrective Action Plan Building 637 Area, Presidio of San Francisco, California.* August.

_____, 1999b. *Corrective Action Plan Building 637 Area Work Plan, Presidio of San Francisco, California.* August.

_____, 2000. *Excavation Report for the Building 637 Area, Presidio of San Francisco, California.* June 22.

_____, 2004. *Completion Report for the Building 637 Area, Presidio of San Francisco, California.* March 31.

TABLES

Table D-1. Comparison of Oxygen Releasing Product Application, Building 1065 and Building 637 CAP Sites

Factor Number	Comparison Factors	Building 637 (a)	Building 1065 Area RU-A
1	Regenesis Product	Oxygen Release Compound (ORC)	ORC Advanced™
2	Oxygen Released by Weight of Product	10%	17%
3	Product Dose Recommended by Regenesis (b)	0.3% By Weight of Soil Treated	0.4% By Weight of Soil Treated
4	Amount of Oxygen Released Per Pound of Soil Treated (c)	0.0003 lbs	0.00068 lbs
5	Estimated Plume Volume	Data Not Presented	28,800 ft^3 (d)
6	Estimated Volume of Soil Excavated or to be Excavated	3,300 ft^3 in Area C 1,000 ft^3 in Area F	15,000 ft^3 (Area 1)
7	Estimated Volume of Soil Treated or to be Treated	3,300 ft^3 in Area C 1,000 ft^3 in Area F 40,000 ft^3 (area between Army excavations)	13,800 ft^3 (e)
8	Average concentration of TPHg in soil	18,000 mg/kg (area between Army excavations)	3,750 mg/kg (Area 1) (f)
9	Average concentration of TPHd in soil	5,000 mg/kg (Areas C & F)	TPHd Not Detected Above Reporting Limit (f)
10	Estimated Weight of Soil in Treatment Area(s)	330,000 lbs in Area C 110,000 lbs in Area F	1,500,000 lbs (Area 1) (g)
11	Estimated Mass TPHg (based on soil concentrations)	5,900 lbs in Area C 1,800 lbs in Area F	5,680 lbs (Area 1) (h)
12	Estimated Mass of TPHd (based on soil concentrations)	20,000 lbs (area between Army excavations)	TPHd Not Detected Above Reporting Limit (f)
13	Concentration of TPHg in groundwater	3,500 ug/L (Area F) 1,300 ug/L (area between Army excavations)	1,320 ug/L (f)
14	Estimated Mass TPHg (based on groundwater concentrations)	0.46 to 0.65 lb (Area F) 7 to 10 lb (area between Army excavations)	Not estimated
15	Demand Factor for Groundwater (i)	7-10	7-10
16	Hydrocarbon Oxygen Demand (j)	3.1 lbs oxygen for every 1 lb hydrocarbons	3.1 lbs oxygen for every 1 lb hydrocarbons
17	Estimated Oxygen Releasing Product Quantity Based on Soil Concentrations	36,000 to 54,000 lbs (Area F) 400,000 to 600,000 lbs (area between Army excavations)	115,600 lbs (Area 1) (k)
18	Estimated Oxygen Releasing Product Quantity Based on Groundwater Concentrations	10 to 20 lbs in Area F 140 to 290 lbs (between excavations)	Not estimated
19	Quantity of Product Recommended by Regenesis	1,000 lbs in Area C 330 lb in Area F	6,000 lbs (Area 1) (l)

Table D-1. Comparison of Oxygen Releasing Product Application, Building 1065 and Building 637 CAP Sites

Factor Number	Comparison Factors	Building 637 (a)	Building 1065 Area RU-A
21	Method of Product Application	Applied during backfill in Areas C and F Injected between excavations using direct push technology after applying during backfill	To be applied, if needed, in bottom of excavations prior to backfill
22	Baseline Groundwater Monitoring Prior to Product Application	Installed and sampled monitoring wells within 4 months after ORC was placed in the excavation and 20 days prior to injection of ORC	Proposed monitoring well installation and sampling within 1 month prior to soil excavation and product application.
23	Groundwater Monitoring After Product Application	Sampled monitoring wells 4 months after baseline sampling and 3 months after injection of ORC.	Proposed groundwater sampling within 2 weeks of product application (if product is applied)
24	Groundwater Parameters Monitored	TPHg, BTEX, DO	TPHg, BTEX, Arsenic, Aluminum, Iron, Manganese, DO, ORP, pH, Temperature, Electrical Conductance (n)

Acronyms/Units:
mg/kg = milligrams per kilogram
lbs = pounds
ug/L = micrograms per liter
ft^3 = cubic feet
TPHg = total petroleum hydrocarbons as gasoline
TPHd = total petroleum hydrocarbons as diesel
BTEX = benzene, toluene, ethylbenzene, and total xylenes
DO = dissolved oxygen
ORP = oxygen reduction potential

Table D-1. Comparison of Oxygen Releasing Product Application, Building 1065 and Building 637 CAP Sites

Footnotes:

(a) Data from published Building 637 Corrective Action Plan reports (*EKI, 1999a, 1999b, 2000, and 2004*). See Data Summary and Figures depicting excavation and ORC injection areas attached.

(b) Regenesis typically recommends between 1% to 6% product per pound of soil. Based on soil type for site and weight of the soil in the area to be treated Amount is calculated by multiplying the percentage (0.003 for Building 637 and 0.004 for Building 1065) by the weight of the soil to be treated to give the pounds of ORC required.

(c) Based on recommended application dose per pound of soil multiplied by the percentage of oxygen released per pound of product.

(d) Plume dimensions estimated by Regenesis based on data presented on Plate 1-3 of the Work Plan (Concentrations Exceeding Cleanup Levels in Soil and Groundwater).

(e) The estimated volume of soil to be treated is the estimated plume volume minus the estimated volume of soil to be excavated.

(f) Data used to calculate average concentration shown in Table D-2.

(g) Estimated weight of soil is the volume of soil to be treated (13,800 ft^3) multiplied by 110 lbs per cubic foot (assuming a soil density of 1.76 grams per cubic centimeter).

(h) Estimated mass of compound is the weight of the soil to be treated (1.5×10^6 lbs) multiplied by the average concentration in soil.

(i) Regenesis recommends the estimated mass of dissolved hydrocarbons be multiplied by an additional demand factor of 7 to 10 to account for residual hydrocarbons in the soil and naturally occurring organic matter in soil that will consume oxygen released from oxygen releasing compound in the smear zone.

(j) Regenesis estimates a stoichiometric relationship of 3.1 lbs of oxygen for every pound of hydrocarbon oxidized.

(k) The estimated number of pounds of ORC Advanced (releasing 17% oxygen by weight) needed to release 3.1 lbs of oxygen per pound of hydrocarbon in the treatment area. The pounds of hydrocarbons in the treatment area were estimated using the average concentration of TPH (full range) multiplied the weight of the soil in the treatment area.

(l) Product quantity is based on the weight of soil and soil type, and is equal to the weight of the soil to be treated multiplied by the recommended application dose ($13{,}800\ ft^3 \times 0.004 \times 110\ lbs/ft^3 = \sim 6{,}000$ lbs).

(m) Quantity of ORC injected in this area was not estimated based on concentrations or soil weight, but was applied based on previous testing in the area, spacing of the injection points, and on how much product the subsurface geologic formation would accept during injection.

(n) See Table 2-1 of the Work Plan.

Checked SG
Approved SLK

Table D-2. Site-Specific Petroleum-Related Concentrations Used to Estimate Average Soil and Groundwater Concentrations, Area 1

Average Concentrations in Soil (a)										
		Boring/Monitoring Well								**Average Concentration (b)**
	Units	1065SB139		1065SB140		1065SB141		1065SB143		
Sample Date		8/12/2003		8/12/2003		8/13/2003		8/13/2003		
Sample Depth	feet bgs	4	7	3.5	6.5	4	6.5	3.5	6	
TPHg	mg/kg	ND(1)	ND(1.2)	ND(1.1)	ND(1.2)	ND(1)	30,000	ND(1.1)	1.6	**3,750**
TPHd	mg/kg	ND(5.2)	ND(5.9)	ND(5.4)	ND(5.9)	ND(5.2)	ND(5.9)	ND(21)	ND(5.9)	**4**
TPHfo	mg/kg	ND(10)	ND(12)	15	ND(12)	ND(10)	ND(12)	300	21	**50**
TPH(unknown diesel)	mg/kg	ND(5.2)	ND(5.9)	ND(5.4)	ND(5.9)	ND(5.2)	ND(5.9)	ND(21)	ND(5.9)	**30**
TPH(Unknown gasoline)	mg/kg	ND(1)	ND(1.2)	ND(1.1)	ND(1.2)	ND(1)	ND(5900)	ND(1.1)	ND(1.2)	**370**
TPH	mg/kg	11	13	22	13	11	33,000	322	29	**4,180**
Benzene	mg/kg	ND(0.0051)	ND(0.005)	ND(0.0045)	ND(0.0049)	ND(0.0053)	2.4	ND(0.0052)	0.001	**0.3**

Average Concentrations in Groundwater (a) (c)										
		Boring/Monitoring Well								**Average Concentration (b)**
	Units	1065HP01	1065PZ1A	1065MW9A	1065SB135	1065SB139	1065SB140	1065SB141	1065SB143	
Sample Date		4/7/1997	8/19/2003	6/9/2003	11/4/2002	8/13/2003	8/12/2003	8/13/2003	8/13/2003	
TPHg	µg/L	ND(50)	310	350	450	170	130	1100	8000	**1,320**
TPHd	µg/L	98	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)	ND(50)	**30**
TPHfo	µg/L	ND(500)	ND(300)	ND(300)	ND(300)	ND(250)	ND(250)	ND(250)	ND(250)	**150**
TPH(unknown diesel)	µg/L	--	--	--	--	ND(120)	63	ND(120)	430	**150**
TPH(Unknown gasoline)	µg/L	--	--	--	--	ND(50)	ND(50)	ND(50)	ND(500)	**80**
TPH	µg/L	373	485	525	625	405	368	1335	8830	**1,620**
Benzene	µg/L	ND(1)	ND(0.5)	33	16	ND(2.5)	0.29	0.30	14	**10**

Acronyms/Units:

bgs = below ground surface
mg/kg = milligrams per kilogram
µg/L = micrograms per liter
TPHg = Total petroleum hydrocarbons as gasoline
TPH = Total petroleum hydrocarbons. Sum of TPH as gasoline, diesel, and motor/fuel oil
ND ( ) = Analyte not detected above laboratory reporting limit. Reporting limit in paranthesis ( ).
-- = not analyzed/not applicable

Footnotes:

(a) Data compiled from Historical Soil and Groundwater Data Summary Tables (Appendix C), Corrective Action Plan Building 1065 Area (*MACTEC, 2007a*).

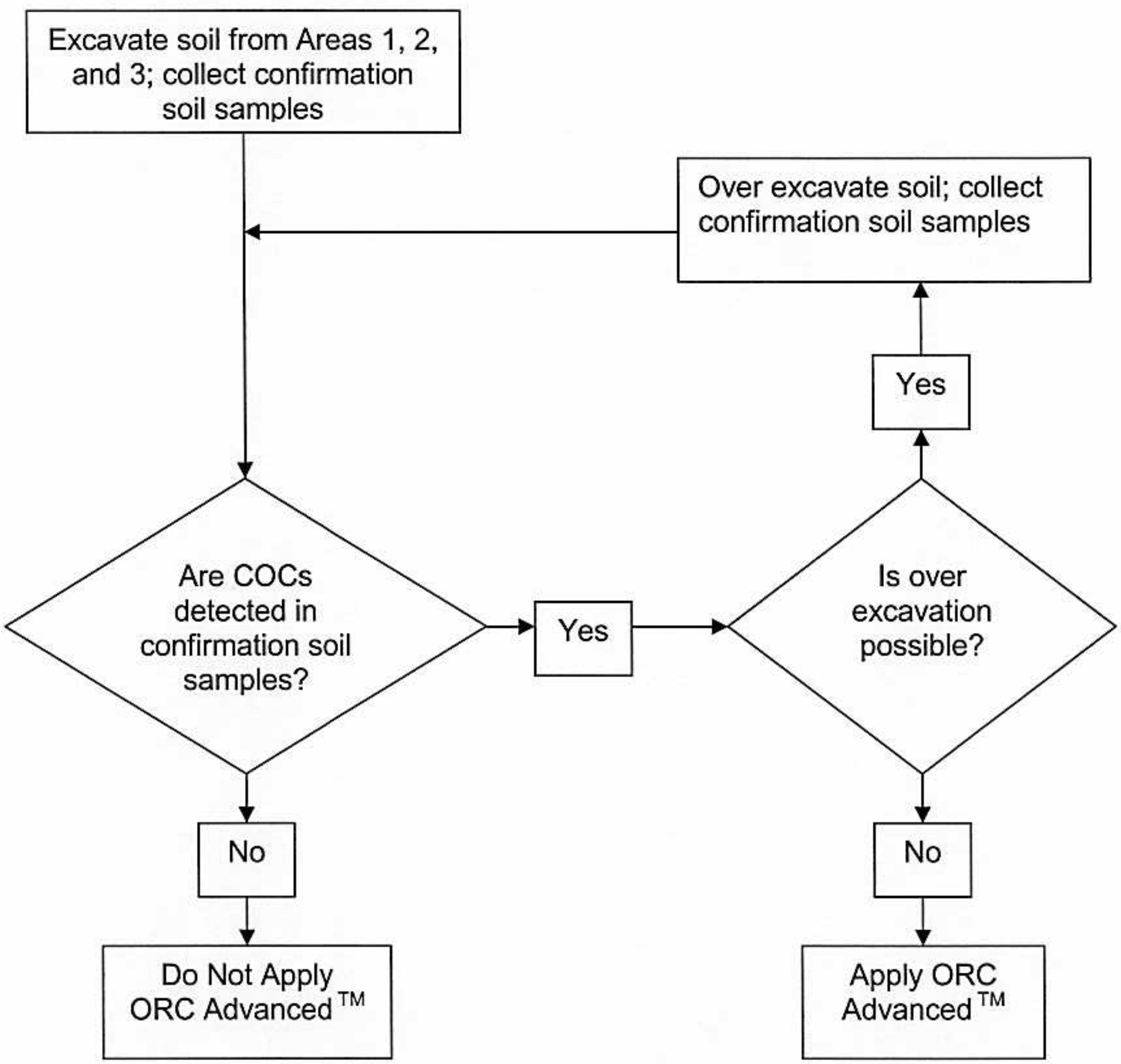
(b) Average concentration of analyte is equal to the sum of the detections and 1/2 of the detection limits (for the results reported as ND) divided by the total number of results.

(c) Maximum reported concentration per location.

Checked SG
Approved SR

FIGURE

Objective: Determine whether oxygen releasing product ORC Advanced ^{TM} should be applied to excavations at RUs-A, Building 1065 CAP Site



MACTEC

Decision-Making and Communications Flow Chart for Oxygen Releasing Product Application in Excavations

FIGURE D-1

Corrective Action Implementation Work Plan,
Building 1065 Area
Presidio of San Francisco, California

DRAWN	JOB NUMBER	APPROVED	CHECKED	DATE	REVISED DATE
MLS	4089030006 00311	SM	SG	5/07	5/07

APPENDIX D

ATTACHMENTS

COMPLETION REPORT FOR THE BUILDING 637 AREA, PRESIDIO OF SAN FRANCISCO, CALIFORNIA (*EKI, 2004*)

- TABLE 4 – STATUS OF GROUNDWATER MONITORING BUILDING 637 AREA
- FIGURE 2 – FINAL EXTENT OF EXCAVATIONS BUILDING 637 AREA
- FIGURE 3 – ORC TREATMENT AREAS AND MONITORING WELL NETWORK, BUILDING 637 AREA

REGENESIS LETTER PROPOSAL – AREA 1
REGENESIS PROJECT EVALUATION FORM PREPARED BY MACTEC – AREA 1
REGENESIS DIRECTIONS FOR ORC ADVANCED SLURRY MIXING
REGENESIS EXCAVATION APPLICATION INSTRUCTIONS

TABLE 4
STATUS OF GROUNDWATER MONITORING - BUILDING 637 AREA
Presidio of San Francisco, California

Well ID	Water-Bearing Zone	Objectives of Monitoring Well	Analytes and Analytical Methods (a)	Required Monitoring Frequency and Duration	Groundwater Monitoring Summary (b)	Proposed Future Work
637-01R	A2	Monitor groundwater flow direction in A2 Zone. Measure TPH-g and BTEX.	TPH-g (EPA 8015M) BTEX (EPA 8021B or 8260B)	Quarterly for 1 year.	Remedial activities were completed in March 2000. The Presidio Trust collected groundwater samples from this well 8 times from June 2000 to December 2002. The maximum TPH-g and xylenes concentrations detected in groundwater were 190 ug/l and 0.9 ug/l, respectively, which are less than the applicable groundwater cleanup levels for TPH-g and xylenes of 13,000 ug/l and 232,000 ug/l, respectively. Benzene, toluene, and ethylbenzene were not detected in groundwater samples.	NFA (c)
637-19	A2	Monitor groundwater flow direction in A2 Zone. Measure TPH-g and BTEX.	TPH-g (EPA 8015M) BTEX (EPA 8021B or 8260B)	Quarterly for 1 year.	Remedial activities were completed in March 2000. The Presidio Trust collected groundwater samples from this well 7 times from May 2001 to December 2002. The maximum xylenes concentration detected in groundwater was 2.7 ug/l, which is less than the applicable groundwater cleanup level for xylenes of 232,000 ug/l. TPH-g, benzene, toluene, and ethylbenzene were not detected in groundwater samples.	NFA (c)
637-26	A1	Monitor groundwater flow direction in A1 Zone. Measure TPH-g, BTEX, and DO downgradient of ORC treatment area.	TPH-g (EPA 8015M) BTEX (EPA 8021B or 8260B) DO (DO Field Probe)	Quarterly for 2 years.	Remedial activities were completed in March 2000. The Presidio Trust collected groundwater samples from this well 8 times from June 2000 to December 2002. The maximum TPH-g, ethylbenzene, and xylenes concentrations detected in groundwater were 620 ug/l, 2.4 ug/l, and 4.9 ug/l, respectively, which are less than the applicable groundwater cleanup levels for TPH-g, ethylbenzene, and xylenes of 13,000 ug/l, 1,000 ug/l, and 232,000 ug/l, respectively. Benzene and toluene were not detected in groundwater samples.	NFA (c)

TABLE 4
STATUS OF GROUNDWATER MONITORING - BUILDING 637 AREA
Presidio of San Francisco, California

Well ID	Water-Bearing Zone	Objectives of Monitoring Well	Analytes and Analytical Methods (a)	Required Monitoring Frequency and Duration	Groundwater Monitoring Summary (b)	Proposed Future Work
637-27	A1	Monitor groundwater flow direction in A1 Zone. Measure TPH-g and BTEX.	TPH-g (EPA 8015M) BTEX (EPA 8021B or 8260B)	Quarterly for 1 year.	Remedial activities were completed in March 2000. The Presidio Trust collected groundwater samples from this well 7 times from May 2001 to December 2002. TPH-g and BTEX were not detected in groundwater samples.	NFA (c)
637-33	A2	Monitor groundwater flow direction in A2 Zone. Measure TPH-g and BTEX.	TPH-g (EPA 8015M) BTEX (EPA 8021B or 8260B)	Quarterly for 1 year.	Remedial activities were completed in March 2000. The Presidio Trust collected groundwater samples from this well 7 times from May 2001 to December 2002. TPH-g and BTEX were not detected in groundwater samples.	NFA (c)
637-34	A1	Monitor groundwater flow direction in A1 Zone. Wetland early-detection well (west of sentry wells).	TPH-g (EPA 8015M) BTEX (EPA 8021B or 8260B)	Quarterly for 2 years, semi-annually thereafter. (d)	Remedial activities were completed in March 2000. The Presidio Trust collected groundwater samples from this well 10 times from June 2000 to August 2003. TPH-g and BTEX were not detected in groundwater samples.	NFA (c)
637-35	A1	Monitor groundwater flow direction in A1 Zone. Wetland sentry well.	TPH-g (EPA 8015M) BTEX (EPA 8021B or 8260B)	Quarterly for 2 years, semi-annually thereafter. (d)	Remedial activities were completed in March 2000. The Presidio Trust collected groundwater samples from this well 10 times from June 2000 to August 2003. The maximum xylenes concentration detected in groundwater was 0.63 ug/l, which is less than the applicable groundwater cleanup level for xylenes (within 150 feet of wetlands) of 130 ug/l. TPH-g, benzene, toluene, and ethylbenzene were not detected in groundwater samples. TPH-g and BTEX concentrations have been non-detect for 5 consecutive monitoring events.	NFA (c)
637-36	A1	Monitor groundwater flow direction in A1 Zone. Wetland sentry well.	TPH-g (EPA 8015M) BTEX (EPA 8021B or 8260B)	Quarterly for 2 years, semi-annually thereafter. (d)	Remedial activities were completed in March 2000. The Presidio Trust collected groundwater samples from this well 10 times from May 2001 to August 2003. TPH-g and BTEX were not detected in groundwater samples.	NFA (c)

TABLE 4
STATUS OF GROUNDWATER MONITORING - BUILDING 637 AREA
Presidio of San Francisco, California

Well ID	Water-Bearing Zone	Objectives of Monitoring Well	Analytes and Analytical Methods (a)	Required Monitoring Frequency and Duration	Groundwater Monitoring Summary (b)	Proposed Future Work
637-37	A1	Monitor groundwater flow direction in A1 Zone. Wetland sentry well.	TPH-g (EPA 8015M) BTEX (EPA 8021B or 8260B)	Quarterly for 2 years, semi-annually thereafter. (d)	Remedial activities were completed in March 2000. The Presidio Trust collected groundwater samples from this well 10 times from June 2000 to August 2003. TPH-g and BTEX were not detected in groundwater samples above laboratory reporting limits.	NFA (c)
637-38	A1	Monitor groundwater flow direction in A1 Zone. Measure TPH-g, BTEX, and DO downgradient of ORC treatment area.	TPH-g (EPA 8015M) BTEX (EPA 8021B or 8260B) DO (DO Field Probe)	Quarterly for 2 years.	Remedial activities were completed in March 2000. The Presidio Trust collected groundwater samples from this well 9 times from June 2000 to March 2003. The maximum TPH-g, toluene, and xylenes concentrations detected in groundwater were 320 ug/l, 4.8 ug/l, and 1.2 ug/l, respectively, which are less than the applicable groundwater cleanup levels for TPH-g, toluene, and xylenes of 13,000 ug/l, 2,100 ug/l, and 232,000 ug/l, respectively. Benzene and ethylbenzene were not detected in groundwater samples.	NFA (c)
637-39R	A1	Monitor groundwater flow direction in A1 Zone. Measure TPH-g, BTEX, and DO downgradient of ORC treatment area.	TPH-g (EPA 8015M) BTEX (EPA 8021B or 8260B) DO (DO Field Probe)	Quarterly for 2 years.	Remedial activities were completed in March 2000. The Presidio Trust collected groundwater samples from this well 7 times from August 2001 to March 2003. TPH-g and BTEX were not detected in groundwater samples.	NFA (c)

TABLE 4
STATUS OF GROUNDWATER MONITORING - BUILDING 637 AREA
Presidio of San Francisco, California

Well ID	Water-Bearing Zone	Objectives of Monitoring Well	Analytes and Analytical Methods (a)	Required Monitoring Frequency and Duration	Groundwater Monitoring Summary (b)	Proposed Future Work
637-40	A2	Monitor groundwater flow direction in A2 Zone. Measure HVOC concentrations until MCLs are achieved.	HVOCs (EPA 8260)	Annually until MCLs achieved for 2 consecutive monitoring events.	Remedial activities were completed in March 2000. The Presidio Trust collected groundwater samples from this well 8 times from May 2001 to March 2003. The maximum TPH-g, benzene, toluene, ethylbenzene, and xylenes concentrations detected in groundwater were 85 ug/l, 0.88 ug/l, 0.97 ug/l, 1.2 ug/l, and 5.6 ug/l, respectively. These concentrations are less than the applicable groundwater cleanup levels for TPH-g, benzene, toluene, ethylbenzene, and xylenes of 13,000 ug/l, 650 ug/l, 2,100 ug/l, 1,000 ug/l, and 232,000 ug/l, respectively. The maximum acetone, c-1,2-DCE, PCE, and vinyl chloride concentrations detected in groundwater were 20 ug/l, 0.9 ug/l, 1.7 ug/l, and 1.1 ug/l, respectively. An MCL for acetone does not exist. The c-1,2-DCE and PCE concentrations are less than their MCLs of 6 ug/l and 5 ug/l, respectively. The maximum vinyl chloride concentration is greater than its MCL of 0.5 ug/l. No other VOCs have been detected. All HVOC concentrations have been below their MCLs for the 2 most recent consecutive monitoring events; thus, the HVOC cleanup level has been met.	NFA (c)

TABLE 4
STATUS OF GROUNDWATER MONITORING - BUILDING 637 AREA
Presidio of San Francisco, California

Well ID	Water-Bearing Zone	Objectives of Monitoring Well	Analytes and Analytical Methods (a)	Required Monitoring Frequency and Duration	Groundwater Monitoring Summary (b)	Proposed Future Work
LF07GW11	A1	Monitor groundwater flow direction in A1 Zone. Measure TPH-g, BTEX, and DO downgradient of ORC treatment area.	TPH-g (EPA 8015M) BTEX (EPA 8021B or 8260B) DO (DO Field Probe)	Quarterly for 2 years.	Remedial activities were completed in March 2000. The Presidio Trust collected groundwater samples from this well 9 times from July 2000 to December 2002. The maximum TPH-g, benzene, toluene, and xylenes concentrations detected in groundwater were 240 ug/l, 2.6 ug/l, 0.7 ug/l, and 0.73 ug/l, respectively. These concentrations are less than the applicable groundwater cleanup levels for TPH-g, benzene, toluene, and xylenes of 13,000 ug/l, 650 ug/l, 2,100 ug/l, and 232,000 ug/l, respectively. Ethylbenzene has not been detected in groundwater samples.	NFA (c)

Notes:

(a) Analytical methods are U.S. Environmental Protection Agency methods (SW-846, Update III), unless otherwise indicated.

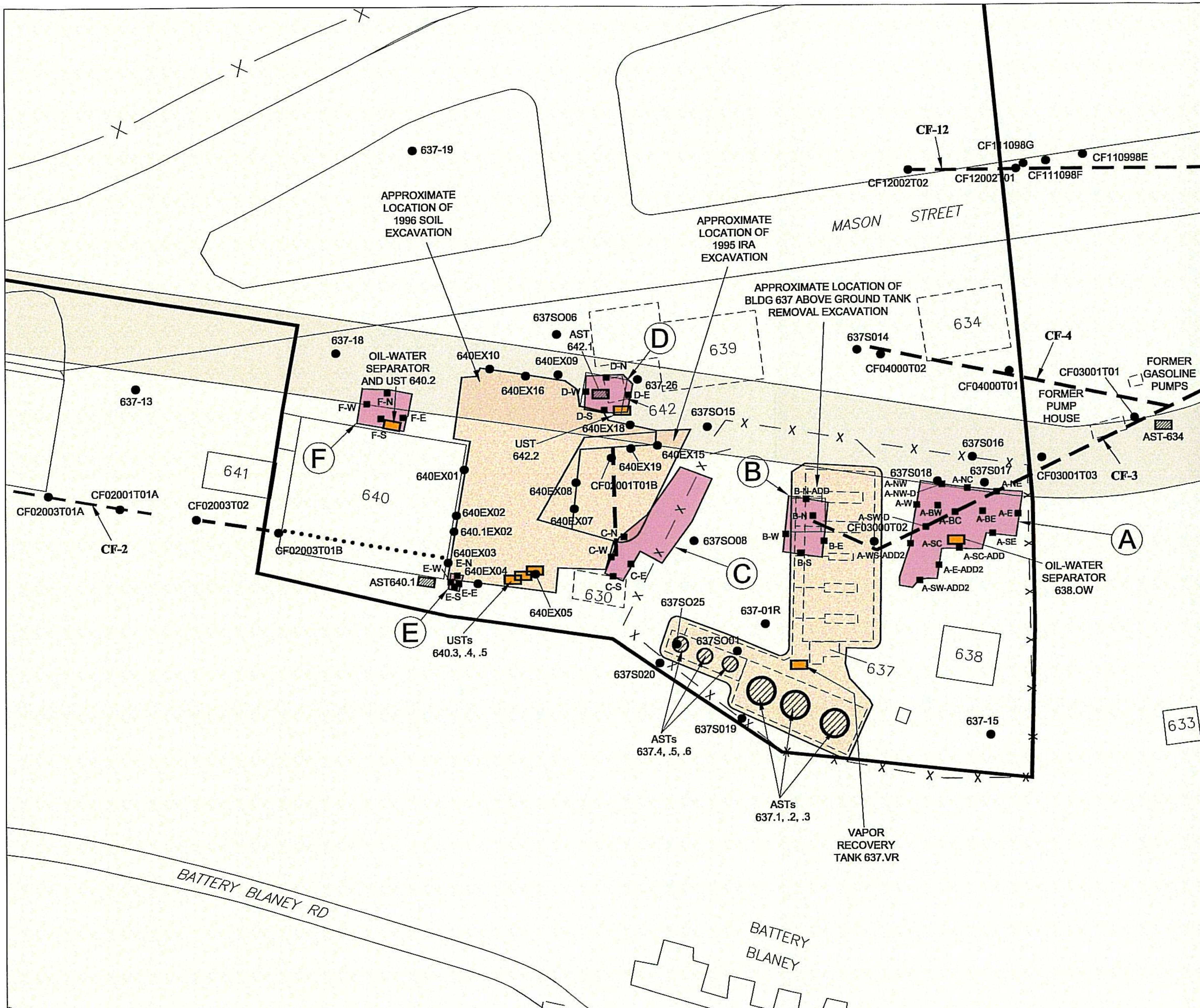
(b) Groundwater monitoring data are tabulated in Appendix B of this document.

(c) The results of groundwater monitoring indicated the requirements of the CAP have been met and no further action ("NFA") is necessary for groundwater, except for the proper decommissioning of the existing monitoring wells.

(d) In accordance with the CAP, the Trust may request to terminate groundwater monitoring after 3 years if at least one of the following conditions is met: (1) the groundwater flow direction in the Building 637 Area is consistently to the north or northwest (i.e., not toward the wetlands); (2) TPH-g has not been detected in the wells for the last four consecutive rounds of monitoring; or (3) the trend of TPH-g concentrations is shown to be stable or decreasing using a statistical evaluation.

Abbreviations:

BTEX	benzene, toluene, ethylbenzene, and xylenes	NFA	no further action
c-1,2-DCE	cis-1,2-dichloroethene	ORC	Oxygen Release Compound, provided by Regenesis
CAP	Final Corrective Action Plan, Building 637 Area	PCE	tetrachloroethene
DO	dissolved oxygen	TPH-g	total petroleum hydrocarbons quantified as gasoline
HVOCs	halogenated volatile organic chemicals	VOCs	volatile organic compounds
MCLs	Maximum Contaminant Levels		



N

0 60 120

(Approximate Scale in Feet)

LEGEND

- Building 637 Area Boundary
- Fence
- Former Building or Structure Location
- Mason Street Realignment
- Former Aboveground Storage Tank (AST) Location
- Former Underground Storage Tank (UST) Location
- Shallow Soil Sampling Location
- Trust Confirmation Soil Sampling Location
- Army Excavation Area
- Trust Excavation Area
- Former Fuel Distribution System (FDS) Line
- FDS Line Abandoned in Place
- 634 Building and Number
- (A) Trust Excavation Area ID
- CF-2 FDS Section ID

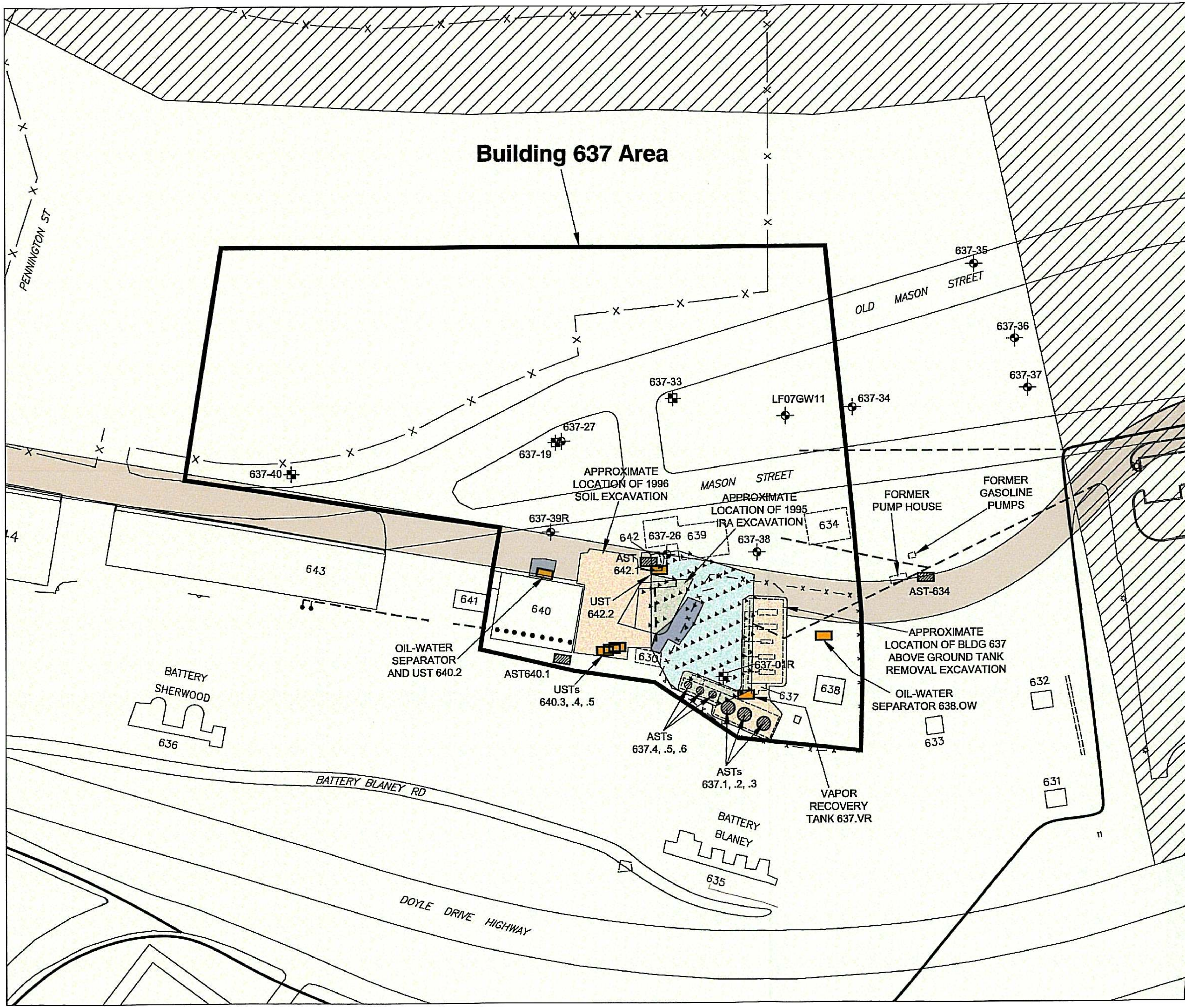
Notes:

1. All locations are approximate.
2. Base map was provided by Department of the Interior, National Park Service.
3. The size and orientation of the USTs and ASTs are schematic (e.g., not representative of actual sizes).
4. Shallow soil indicates soil samples collected from depths less than 4 feet below ground surface ("bgs").
5. The northern portion of Area C was excavated to fixed dimensions; confirmation sampling was not conducted.

Erler & Kalinowski, Inc.

Final Extent of Excavations
Building 637 Area

Presidio Trust
San Francisco, CA
March 2004
EKI A000003.10
Figure 2



N

0 120 240

(Approximate Scale in Feet)

LEGEND

- Fence
- Former Building or Structure Location
- Mason Street Realignment
- A1 Zone Monitoring Well
- A2 Zone Monitoring Well
- Saltwater Ecological Protection Zone
- Former Aboveground Storage Tank (AST) Location
- Former Underground Storage Tank (UST) Location
- Former Excavation Area
- Former Fuel Distribution System (FDS) Line
- FDS Line Abandoned in Place
- 634 Building and Number
- Location Where ORC was Placed Excavation Backfill (4 to 6 feet bgs)
- Approximate ORC Injection Area ("▸" Represents Approximate ORC Injection Point)

Notes:

1. All locations are approximate.
2. Base map was provided by Department of the Interior, National Park Service.
3. The size and orientation of the USTs and ASTs are schematic (e.g., not representative of actual sizes).

Erler & Kalinowski, Inc.

ORC Treatment Areas and Monitoring Well Network
Building 637 Area

THE PRESIDIO TRUST

Presidio Trust
San Francisco, CA
March 2004
EKI A000003.10

Figure 3

REGENESIS

January 25, 2007 **Proposal No. 3JB0798RII**

Scott Graham
MACTEC Engineering Consulting
5341 Old Redwood Highway, Suite 300
Petaluma, California 94954
E-mail: srgraham@mactec.com

Subject: Application of ORC *Advanced* (Advanced Formula Oxygen Release Compound) to Accelerate the Natural Attenuation of Contaminants of Concern (COCs) at the Presidio Building 1063 Site in San Francisco, CA

Dear Mr. Graham:

Thank you for your interest in Regenesis and our Advanced formula Oxygen Release Compound (ORC *Advanced*™) product. We have reviewed the information that you provided for the Presidio Building 1063 site in San Francisco, CA. In the following sections of this proposal, we will discuss the use of ORC *Advanced*, design and cost information, delivery of ORC *Advanced* to the subsurface, a recommended groundwater monitoring program, and the performance goals for this particular project. In addition, this proposal should be considered preliminary because some assumptions were made regarding the current biogeochemical conditions of the aquifer and the extent of the contaminant plume requiring treatment. We look forward to working with you on developing a site-specific strategy that will help meet your objectives for the site.

Use of Advanced formula Oxygen Release Compound (ORC *Advanced*™) to Accelerate Bioremediation

Advanced formula Oxygen Release Compound (ORC *Advanced*) is a patented formulation of phosphate-intercalated calcium oxyhydroxide that is a timed-released source of oxygen. ORC *Advanced* releases oxygen in the dissolved-phase when it is hydrated. Numerous studies have shown that the lack of oxygen can limit the ability of naturally occurring microorganisms (aerobes) to degrade certain compounds. ORC *Advanced* provides terminal electron acceptors to support the oxidative biodegradation of many types of aerobically degradable compounds including but not limited to: petroleum-based hydrocarbons (e.g. Toluene) and chlorinated hydrocarbons (e.g. Vinyl Chloride). ORC *Advanced* is manufactured as a fine powder that can be installed in the subsurface in the following ways: (1) mixed with water to form a slurry that can be injected into both the saturated and unsaturated zones, and (2) added as a soil amendment to the backfill material used in excavation applications. The use of oxygen sources such as ORC *Advanced* is recognized as a sensible strategy for engineering accelerated bioattenuation at project sites contaminated with aerobically degradable compounds.

Preliminary Design and Cost Information for Full Scale Remediation

Based on the provided data and earlier conversations with you, Regenesis understands that the full-scale treatment at the subject site will be the addition of ORC *Advanced* as a soil amendment to the backfill of the planned excavation. The recommended dosage of ORC *Advanced* for this application is based on the parameters in the following table.

Excavation Application Parameters	Specification
Estimated contaminant concentrations in groundwater prior to excavation activities	[TPHg] = 8 mg/L
Planned excavation dimensions	50 feet x 60 feet x 8.5 feet
Saturated thickness to be treated	6 feet
Material requirement	6,000 lbs (0.4% Recommended)
Material cost @ $8.25/lb	$49,500.00 plus tax and shipping fees

Total ORC *Advanced*™ Project Cost

The total cost of an ORC *Advanced*-accelerated bioremediation project can be estimated using the following items:

- ORC *Advanced*™ material ($49,500.00), shipping fees, and sales tax
- Fieldwork costs associated with the installation of ORC *Advanced* (Customers are responsible for selecting the drilling subcontractor that will be used for the project.)
- Groundwater monitoring well construction (If additional monitoring wells are needed to properly monitor the performance of the project.)
- All fieldwork and laboratory analysis associated with periodic groundwater monitoring events
- Consultant oversight and report generation

The costs presented in this proposal are for ORC *Advanced* material costs for a one-time application only. The need to re-apply ORC *Advanced* depends on your plume management strategy, site-specific biodegradation performance, and the ultimate remediation goals for the site, as well as, other technical or regulatory considerations. As can be seen, project costs are directly related to the period of time needed to achieve the site-specific goals.

Excavation Application for ORC *Advanced*™ projects

Regenesis understands that contaminated soils at the subject site will be removed by excavation activities. We also understand that the application at the subject site will be the addition of ORC *Advanced* as an amendment to the soil backfill. This product can be installed by the suggested methods outlined below or by other appropriate methods.

- **<u>Method No. 1</u>:** Create an ORC *Advanced* slurry by adding water to the ORC *Advanced* powder. The solids content of the slurry used for this application is essentially irrelevant because the amount of ORC *Advanced* material that needs to be placed in the excavation is a known quantity. Typically, a 20% ORC *Advanced* slurry is used for this application. Based on our experience, we have found that a high volume, low pressure pump can be used to distribute the ORC *Advanced* slurry in the excavation. The ORC *Advanced* slurry can be added simultaneously with the backfill material or can be placed into standing water prior to backfilling.

- **<u>Method No. 2</u>:** The ORC *Advanced* powder or ORC *Advanced* slurry can be mixed with the backfill material before it is placed in the excavation. The "mixed" material can then be placed via backhoe into the excavation.

- **<u>Method No. 3:</u>** ORC *Advanced* powder or an ORC *Advanced* slurry can be added directly to the excavation: ORC *Advanced* can either be added to the bottom of the excavation or it can be added (recommended) to a pre-determined vertical interval as the soil backfilling is being completed. The ORC *Advanced* powder or ORC *Advanced* slurry can also be mixed with backfill material using a backhoe (or equivalent). **Although this application method allows for the ORC *Advanced* to be placed in specific locations, it is not recommended because of Health & Safety concerns. (ORC *Advanced* is a fine powder that becomes airborne very easily and inhalation of large amounts of any fine powder can cause soft tissue irritation).**

Recommended Groundwater Monitoring Program for ORC *Advanced*™ Projects

In order to validate the effectiveness of natural attenuation processes (ORC *Advanced*-enhanced treatment), we recommend conducting groundwater monitoring at selected wells. Also, a baseline round of sampling should be performed to identify the aquifer conditions prior to the installation of this material. After ORC *Advanced* has been installed into the subsurface, groundwater samples can be collected on a bi-monthly or quarterly basis. Once the initial biodegradation and geochemical trends have been identified, the monitoring frequency can be changed to a semi-annual or annual program. The groundwater monitoring program should employ low flow groundwater sampling techniques and include the measurement of the following field/chemical parameters:

- All COCs
- Field redox parameters: oxidation-reduction potential (ORP), pH, dissolved oxygen (DO), dissolved manganese, and dissolved (ferrous) iron
- Biochemical Oxygen Demand ($BOD_{5\text{-day}}$) and Chemical Oxygen Demand (COD) at selected groundwater monitoring wells within treatment area

Groundwater Monitoring Locations

The following table outlines the suggested locations and significance of monitoring wells used to monitor the progress of an ORC *Advanced* -based project.

Location	Significance
Background (Outside the groundwater plume)	Allows for the changes in natural attenuation conditions induced by addition of ORC *Advanced* to be compared to background levels
Upgradient of treatment zone	Provides a measure of contaminant and competing electron acceptor flux entering treatment zone
Inside treatment zone	Provides information on how ORC *Advanced* is affecting the aquifer conditions and contaminant concentrations
Downgradient of treatment zone	Provides information on the effect ORC *Advanced* is having on the biodegradation rates of contaminants and on aquifer conditions and confirms the mitigation migration

Regenesis appreciates the opportunity to provide this information for your project. Please feel free to contact Jack Peabody, Regenesis' Western Regional Manager, at (925) 944-5566 (e-mail at jpeabody@regenesis.com) or me at (949) 366-8000 x149 (e-mail at jbiondolillo@regenesis.com) any time.

Sincerely,

John Biondolillo

John Biondolillo
Manager of Technical Services, West Region

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AREA 1

PROJECT EVALUATION FORM

REGENESIS

Advanced Technologies for Groundwater Resources

www.regenesis.com
949-366-8000

DESIRED REMEDIAL APPROACH:

☑ **Aerobic Bioremediation** (ORC *Advanced*®, ORC®)

☐ **Anaerobic Bioremediation** (HRC *Advanced*™, HRC®, HRC-X®)

☐ **Chemical Oxidation** (RegenOx®)

☐ **Bioaugmentation** (Bio-Dechlor INOCULUM®, PM1)

☐ **Chromium Remediation** (MRC™)

☐ **Unknown**

When would you like to have the design estimate completed by[1]? September (month) 29 (day)

ABOUT THE PROJECT

Project name Presidio Building 1063 Project number________

Project City San Francisco Project State CA Project Zip________

Main Project contact Scott Graham (srgraham@mactec.com or 707-793-3810)

Lead regulatory agency (oversight) DTSC

ABOUT THE SITE:

*Contaminant(s) of concern (e.g. BTEX, PCE) TPHg, Benzene

Age of Plume >10 years

*Site cleanup objectives Clean Closure: Soil: TPHg <100 mg/kg, B <0.005 mg/kg; Water: TPHg <0.77 mg/L, B <0.001 mg/L

Have other remedial methods been used at the site? ☐ Yes ☐ No

ADDITIONAL INFORMATION NEEDED TO EVALUATE THE SITE:

- *Planned Application Type

  ☐ Source ☐ Plume ☐ Barrier ☑ Excavation ☐ Other

	AVAILABLE & INCLUDED	
• *Site Map	☑ Yes	☐ No
• *Tabulated analytical data that includes COCs for monitoring wells of interest	☑ Yes	☐ No
• Groundwater Contour Map & Plume Map	☑ Yes	☐ No
• Cross-sections, preferably with COCs concentrations indicated	☐ Yes	☐ No
• Boring logs and well completion information (**for key wells only**)	☐ Yes	☐ No

* **FIELDS MARKED WITH ASTERISKS INDICATE PARAMETERS CRUCIAL FOR THE DESIGN PROCESS**

[1] Typical turnaround time for design estimates is 5-10 business days. Quicker estimates are possible depending on current proposal load as well as thoroughness and conciseness of information provided. You will be notified if we will not be able to accommodate your requested turnaround time.

ABOUT THE SOIL, GROUNDWATER & AQUIFER

*Depth to groundwater (ft) 4

*Annual groundwater fluctuation (ft) 3.5 to 6

*Thickness of the contaminated saturated zone (ft) 5

*Planned treatment thickness (if different from above) (ft) 2 feet (top of water column), 4-6 feet bgs

*Aquifer material – soil type(s) Fill - clay, silt, sand, gravel and debris overlying reducing bay mud

Gradient (ft/ft & direction) North 0.02 feet/foot

Porosity (total and effective) (%) total 0.4

Hydraulic conductivity (estimated or tested) (ft/day) ______

*Seepage velocity (ft/day) ______

Total Organic Carbon (TOC) (mg/kg) 0.005

Bulk density (lbs/yd^3) 1.76 g/cm3

ABOUT THE PLUME & CONTAMINANT(S)

Source area dimensions/excavation dimensions (ft) 50' X 60' excavation

Dissolved plume dimensions (ft) ______

*Size of desired treatment area (ft) 50' X 60'

*COCs maximum concentrations (mg/L or mg/kg) Soil: TPHg 30,000 mg/kg, B 2.4 mg/kg; Water: TPHg 8 mg/L, B 0.014 mg/l

*COCs average concentrations (mg/L or mg/kg) Soil: TPHg 4,500 mg/kg, B 0.6 mg/kg; Water: TPHg 1.8 mg/L, B 0.003mg/L

Is NAPL present? ☑ No ☐ Yes - Last measured: ______ Thickness: ______ inches

ABOUT NATURAL ATTENUATION PARAMETERS (not all will be applicable for each site)

Dissolved Oxygen (mg/L)	0.7	Oxidation-Reduction Potential (mV)	
Total iron (mg/L)	8	Total manganese (mg/L)	0.4
Dissolved iron (mg/L)		Dissolved manganese (mg/L)	
Nitrate (mg/L)	<0.05	Sulfate (mg/L)	19
Methane (mg/L)	10	Ethene/Ethane (mg/L)	<0.005
BOD (biological oxygen demand)		pH	7.0
COD (chemical oxygen demand)		TOD (total oxidant demand)	

Is an upcoming field event being planned in which some or most of the above requested information could be collected? ☐ **Yes** ☑ **No**

Please return the form and supporting information to:
REGENESIS - Technical Services Department
1011 Calle Sombra
San Clemente, CA 92673
Ph# (949) 366-8000 Fax# (949) 366-8090
E-mail: tech@regenesis.com

Please Include Your Contact Information:
COMPANY MACTEC
ADDRESS 5341 Old Redwood Highway, Suite 300
CITY Petaluma **STATE** CA **ZIP** 94954
PHONE (707) 793-3810 **FAX** (707) 793-3900
E-MAIL srgraham@mactec.com

REGENESIS

DIRECTIONS FOR ORC *Advanced*™ SLURRY MIXING

1. Open the 5-gallon bucket and remove the pre-measured bag of ORC *Advanced* (each bag contains 25 lbs of ORC *Advanced*).

2. Measure and pour water into the 5-gallon bucket according to the desired slurry consistency (a slurry calculation table is available on the Regenesis software in the Appendix tab):

% Solids	Quantity of ORC *Advanced* (lbs)	Quantity of Water (gal)
65	25	1.6
60	25	2.0
55	25	2.5
50	25	3.0
45	25	3.7
40	25	4.5
35	25	5.6
30	25	7.0
25	25	9.0
20	25	12.0

3. Add the corresponding quantity of water to the pre-measured quantity of ORC *Advanced*.

4. Use an appropriate mixing device to thoroughly mix the ORC *Advanced* and water together. A hand-held drill with a "jiffy mixer" or a stucco mixer on it may be used in conjunction with a small paddle to scrape the bottom and sides of the container. Standard environmental slurry mixers may also be used, following the equipment instructions for operation. For small quantities, the slurry can be mixed by hand if care is taken to blend all lumps into the mixture thoroughly.

CAUTION: **ORC *Advanced* may settle out of slurry if left standing.** ORC *Advanced* eventually hardens into a cement-like compound and cannot be re-mixed after that has occurred. Therefore, mix immediately before using to ensure that the mixture has not settled out. **Do not let stand more than 30 minutes.** If a mechanical slurry mixer attached to a pump is being used, the material may be cycled back through the mixer to maintain slurry suspension and consistency.

REGENESIS

Advanced formula Oxygen Release Compound (ORC *Advanced*™)

EXCAVATION APPLICATION INSTRUCTIONS

SAFETY

Pure ORC *Advanced* is shipped to you as a fine powder rated at 325 mesh (passes through a 44 micron screen). It is considered to be a mild oxidizer and should be handled with care while in the field. Field personnel should take precautions while applying the pure ORC *Advanced*. Typically, the operator should work up wind of the product as well as use appropriate personal protection equipment (PPE). These would include eye protection, respiratory protection and gloves as deemed appropriate by exposure duration and field conditions.

Application of ORC *Advanced* should never be applied by personnel within the tank excavation, unless proper shoring or sidewall cutback is in place.

GENERAL GUIDELINES

Installation of ORC *Advanced* should be within the tank excavation floor and within an adequate backfill thickness to account for the anticipated groundwater "smear zone".

Optimum treatment effectiveness is obtained when ORC *Advanced* is mixed as thoroughly as possible with the backfill material. The more evenly distributed the ORC *Advanced* slurry/powder is within the excavation backfill, the more effective the treatment.

The quantity of ORC *Advanced* to be used should be calculated prior to moving into the field for installation. Generally it is applied at a rate of 0.1 to 1.0% by weight of the soil matrix. A 0.15% weight of ORC *Advanced* to weight of backfill calculates as follows:

- 25 lb. ORC *Advanced* /0.15% = 16,667 lbs. of soil matrix.
- Thus, to achieve a 0.15% mixture of ORC *Advanced* in the backfill material, 25 lb. of pure ORC *Advanced* should be mixed into ~ 8 tons (16,667 lbs. ÷ 2,000 lbs./ton) of backfill, or approximately 5.5 - 8 cubic yards of soil depending on field conditions. Professional judgment should be used to select the appropriate soil mass per cubic yard for designing each site treatment.

CHOOSING THE FORM OF INSTALLATION:

Pure ORC *Advanced* is shipped to you in a powder form. Weather conditions (especially wind) may have a direct effect on the application of ORC *Advanced* as a tank backfill amendment.

Application of the dry powder may be difficult in windy conditions. To counter the effects of wind (and the subsequent potential loss of ORC *Advanced*), Regenesis recommends that a water source or a spray tank be on-site to wet down the ORC *Advanced* and the backfill material as ORC *Advanced* is applied.

Application of ORC *Advanced* in a slurry format is a very effective method and eliminates the wind issue.

Four somewhat different installation conditions can be encountered in the field:

- ORC *Advanced* in a pea gravel back-fill. ("Type 1")
- ORC *Advanced* in a soil back-fill. ("Type 2")
- ORC *Advanced* mixed in native soil in the bottom of a tank pit. ("Type 3")
- ORC *Advanced* installed in soil under standing water in bottom of a tank pit ("Type 4")

A single tank pit excavation can include more than one of these conditions, depending on the site and extent of treatment. Instructions for each condition are discussed separately in the following sections. After the installation instructions are detailed instructions for mixing the slurry, if that is the option chosen.

INSTALLATION INSTRUCTIONS:

Type 1

<u>ORC *Advanced* in a pea gravel back-fill</u>

The easiest method for installing ORC *Advanced* in pea gravel back-fill is to mix the ORC *Advanced* in the material in a backhoe or skiploader bucket before placing it in the excavation.

Dry Powder method

Into each scoop of back-fill material add the appropriate portion of ORC *Advanced* being installed. Generally, it is advisable to moisten the material in the bucket to reduce wind blown ORC *Advanced* loss. Excessive winds make this method not feasible.

After mixing the dry powder in the bucket, it is dumped into the bottom of the excavation. The backhoe bucket can be used for further mixing in the excavation.

Slurry method

Mix a 63% solids slurry of ORC *Advanced* and water (see "Steps to make ORC *Advanced* slurry). This relatively thick slurry is used to help keep the ORC *Advanced* dispersed through the pea gravel, even when it contacts water in the bottom of the excavation during installation. It is generally desirable to avoid having the ORC *Advanced* run down through the pea gravel and collect in the bottom of the excavation. The thick slurry addresses this issue.

In each scoop of back-fill material, add the appropriate amount of ORC *Advanced* slurry. Pre-mix the materials in the backhoe bucket After mixing, dump the slurry and back-fill into the bottom of the excavation. The backhoe bucket can be used for further mixing in the excavation.

If the slurry method is being used, observe the physical behavior of the ORC *Advanced* in the fill material. If the ORC *Advanced* collects at the bottom of the back-fill material, increase the percent solids content by reducing the amount of water being used to make the slurry.

Type 2

ORC *Advanced* in a soil back-fill

Follow the instructions for the pea gravel back-fill method, <u>except</u>:

If the slurry method is being used, the solids content should be reduced. Typically a 50% solids is appropriate, although soil conditions sometimes dictate lower solids contents (see "Steps to make ORC *Advanced* slurry").

Type 3

ORC *Advanced* mixed in native soil in the bottom of the tank pit

When ORC *Advanced* is added to the bottom of a tank pit it may be done by backhoe or injection. <u>CAUTION</u>: Personnel should never work within the tank excavation, unless proper shoring or sidewall cutback is in place.

Backhoe method

A skilled backhoe operator can distribute the ORC *Advanced* around the bottom of the tank excavation and, using the bucket, mix it thoroughly. If there are no winds, it may be possible to:

1. Put the dry ORC *Advanced* powder in the backhoe bucket,
2. Lower it to the bottom of the pit,

3. Gently deposit the ORC *Advanced* evenly on the remaining soil,
4. Use the bucket to mix the powder into the soil,
5. To mitigate dusting, if necessary, spray water into the excavation during the process.

An alternative backhoe method is to use a 50% (or less) solids ORC *Advanced* slurry (see "Steps to make ORC *Advanced* slurry) in place of the dry powder. This eliminates the dusting problem, and in some cases enhances the even distribution of ORC *Advanced* into the soil. Observe the slurry mixing behavior in the bottom of the excavation, and adjust the water content of the slurry to optimize mixing, if necessary.

Injection method

If available, a pump and root feeder may be used to inject an ORC *Advanced* slurry into the excavation floor. This may require a more dilute slurry mix, and care should be taken to assure that the solids do not settle out of the slurry prior to injection.

Type 4

<u>ORC *Advanced* installed in standing water in the bottom of a tank pit</u>

Application of ORC *Advanced* into tank excavations with standing water requires the operator apply ORC *Advanced* in a slurry form. ORC *Advanced* powder application in this scenario is not advised because a portion of the ORC *Advanced* particle fraction is not likely to pass through the surface tension of the standing water. <u>Caution:</u> Personnel should never work within the tank excavation, unless proper shoring or sidewall cutback is in place.

Backhoe method

A skilled backhoe operator can distribute the ORC *Advanced* slurry within the excavation, and mix it into the soil underlying the standing water with the bucket. Steps for installation:

1. Mix a high solids content ORC *Advanced* slurry (63% solids). See ("Steps to make ORC *Advanced* slurry").
2. Pour slurry into the backhoe bucket.
3. Lower the bucket to the standing water level in the excavation, and deposit the slurry as evenly as possible across the excavation floor. The dense slurry (63% solids is 1.6 gms. per ml) will tend to make the majority of the slurry sink quickly to the bottom of the water layer.
4. Use the bucket to mix the slurry into the soil.
5. Water in the vicinity of the ORC *Advanced* slurry will often turn white and milky, since some of the ORC *Advanced* is dispersed within the standing water. This provides

additional dispersion within the standing water and back-fill material as it is added to the excavation.

Injection method

If available, a pump and root feeder may be used to inject an ORC *Advanced* slurry into the soil in an excavation. This may require a more dilute slurry mix, and care should be taken to assure that the solids do not settle out of the slurry prior to injection.

STEPS TO MAKE ORC *Advanced* SLURRY:

ORC *Advanced* powder is shipped to you in pre-measured batches. Each batch is contained in a plastic bag which is shipped in a 5-gallon bucket.

- Remove the pre-measured ORC *Advanced* bag from the 5-gallon bucket and open
- Measure and pour the appropriate amount of water from the following table into the 5-gallon bucket:

Slurry Solids Content (%)	Lbs of ORC *Advanced*	Gallons of Water
63%	25 lbs.	1.8 gal.
50%	25 lbs.	3.0 gal.

- Add the entire ORC *Advanced* pre-measured bag to the water (25 pounds). If slurry solids contents of less than 50% are desired, the quantity of ORC *Advanced* per batch mixed in the bucket must be reduced. For example, a bucket containing four gallons of water would require 22.4 pounds of ORC *Advanced* to make a 40% solids slurry, and 16.6 pounds of ORC *Advanced* to make a 33% slurry.
- Use an appropriate mixing device to thoroughly mix ORC *Advanced* and water. Regenesis recommends use of a 0.5 Horsepower (minimum) hand held drill with a "jiffy mixer" or stucco mixer. A common paint paddle can be used to scrape the bottom and sides of the container to ensure thorough mixing. Standard environmental slurry mixers may also be used.
- After mixing, small amounts of water can be added to adjust the consistency of the slurry.
- When slurries are used, the early batches should be observed in the process of mixing with the soil. Each site can vary, due to soil type and moisture content. Based on professional judgment, additional water can be added to subsequent slurry batches.

ORC *Advanced* slurry should be used ASAP; if the ORC *Advanced* slurry has been standing more than 15 minutes, it should be remixed immediately before using. Do not let stand more than 30 minutes without stirring. Otherwise, the slurry will begin to harden into a weak cement.

REGENESIS 1011 Calle Sombra, San Clemente, CA 92673-6244
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